# SECTION 21 00 00

# BASIC FIRE SUPPRESSION REQUIREMENTS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Work Included: Work included in 21 00 00 applies to Division 21 work to provide materials, labor, tools, permits and incidentals to provide and make ready for Owner's use complete, operable and approved fire suppression systems for proposed project.

B. Refer to Architectural, Structural, Mechanical, Plumbing, Electrical, and Civil Drawings for additional information relating to the fire suppression system.

C. Related Work Specified Elsewhere:
1. Contents of Section applies to Division 21 specifications.
2. Requirements of Section are a minimum for Division 21 Sections, unless otherwise stated in each Section, in which case that Section's requirements take precedence.

D. Products furnished and installed under Division 21, with electrical connections not provided under Division 21:
1. Tamper switches.
2. Waterflow detector.
3. Alarm bells, exterior.
4. High/low pressure alarm switch.
5. Pressure switch.
6. Jockey pumps.
7. Pump controllers.

### 1.2 DEFINITIONS

A. Following is a list of abbreviations generally used in Division 21:

| | | |
|---|---|---|
| 1. | AHJ | Authority Having Jurisdiction |
| 2. | ANSI | American National Standards Institute |
| 3. | ASME | American Society of Mechanical Engineers |
| 4. | ASTM | American Society for Testing and Materials |
| 5. | ASSE | American Society of Sanitary Engineering |
| 6. | AWWA | American Water Works Association |
| 7. | CBC | California Building Code |
| 8. | CEC | California Electrical Code |
| 9. | CMC | California Mechanical Code |
| 10. | CPC | California Plumbing Code |
| 11. | ETL | Electric Testing Laboratories |
| 12. | FM | FM Global |
| 13. | HVAC | Heating, Ventilating and Air Conditioning |
| 14. | MSS | Manufacturers Standardization Society |
| 15. | NEC | National Electric Code |
| 16. | NEMA | National Electrical Manufacturers Association |
| 17. | NFPA | National Fire Protection Association |
| 18. | OSHA | Occupational Safety and Health Administration |
| 19. | UL | Underwriters Laboratories Inc. |
| 20. | UPC | Uniform Plumbing Code |

B. Provide: To furnish and install, complete and ready for the intended use.

C. Furnish: Supply and deliver to the project site, ready for unpacking, assembly and installation.

D. Install: Includes unloading, unpacking, assembling, erecting, installation, applying, finishing, protecting, cleaning and similar operations at the project site as required to complete items of work furnished by others.

## 1.3 ADDITIONAL DEFINITIONS TO DIVISION 01

A. Code: Indicates the Regulatory Requirements as applicable to that reference.

B. AHJ: Indicates reviewing authorities, including the local fire marshal, the Owner's insurance underwriter, Owner's representative, and any other reviewing entity whose approval is required to obtain systems acceptance.

## 1.4 ADDITIONAL REQUIREMENTS TO DIVISION 01

A. Submit the following for review. Include in operations and maintenance manual.

B. Shop Drawings, Calculations, Component Manufacturer's Data Sheets: Submit as one complete standalone package to AHJ, Owner's insurance underwriter, and Engineer. Drawings shall show information required by NFPA 13 and 14, including room names and occupancy classifications. Refer to individual Specification Sections for additional requirements for the shop drawings, calculations and specific items required in product data submittal.
   1. Shop Drawings: Provide shop drawings which include physical characteristics, electrical characteristics, device layout plans, wiring diagrams, and the like.
   2. Calculations: Hydraulic, sway brace, air compressor, antifreeze expansion tank, fire suppression water tank, fire pump, and the like calculations.
   3. Product Data: Submit manufacturer's technical data, installation instructions and dimensioned drawings for products, sprinklers, equipment and devices installed, supplied or provided. Submit at one time in 3-ring binder, tabbed and referenced to match the Contract Documents.
   4. Maintain an updated product submittal package to be included in the final operation and maintenance documentation.

C. Operation and Maintenance Documentation: Copies of certificates of code authority acceptance, code-required acceptance tests; test reports, parts lists, maintenance information for equipment, valves, and other special guarantees, certificates of warranties, and the like, specified elsewhere herein or indicated on Drawings. Record Drawings, water supply flow test, calculations, manufacturer's data sheets and operation and maintenance instructions, servicing requirements, test reports and certificates, Contractor's Material and Test Certificates for Aboveground Piping/Underground Piping and NFPA 25.

D. Close-out Documentation: Submit fire suppression code authority certification of inspection.

E. Record Drawings:
   1. Show changes and deviations from the Drawings. Include issued Addendum and change order items.
   2. Make changes to the Drawings in a neat, clean, and legible manner.

F. Guaranty: Guaranty systems against defective equipment, materials and workmanship for a period of 1 year after Owner's acceptance.

## 1.5 QUALITY ASSURANCE

A. Where Contract Documents are at variance with applicable codes governing work, code and local jurisdiction requirements take precedence, and include cost necessary for code compliance or local jurisdiction compliance in bid price. Machinery and equipment to comply with Occupational Safety and Health Act of 1970, as currently revised, as interpreted for equipment manufacturer requirements.

B. Qualifications: Company specializing in fire-suppression sprinkler, fire-suppression standpipe and hose, fire pump, systems of similar type and scope with 3 years experience.

C. In addition to state regulatory requirements for licensing of contractor and design of fire suppression systems, construction drawings, hydraulic, sway brace, fire pump, and the like calculations to be sealed and signed by a professional engineer licensed in the state of California. This is required to comply with San Mateo County Community College District Design Standards.

D. Mechanical Drawings: Drawings are intended to be diagrammatic and are based on one manufacturer's equipment. They are not intended to show every item in its exact dimensions, or details of equipment or proposed systems layout. Verify actual dimensions of systems (i.e., equipment and piping) and equipment proposed to assure that systems and equipment will fit in available space and conform to code location. Contractor is responsible for design and construction costs incurred for equipment other than basis of design, including but not limited to architectural, structural, electrical, fire sprinkler, standpipe, fire pump, and fire extinguishing systems.

E. Requirements: As a minimum requirement, work in accordance with following rules and regulations and applicable laws: Apply edition as enforced by AHJ unless otherwise stated. Comply with state and local amendments.
1. OSHA.
2. Related supplements and standards.
3. State of California and local jurisdictional requirements.
4. ASCE 7, Minimum Design Loads for Buildings and Other Structures, as adopted by AHJ.
5. CBC, as adopted by AHJ, California Building Standards Code.
6. CFC, as adopted by AHJ, *California Fire Code*.
7. CMC, as adopted by AHJ, California Mechanical Code.
8. CPC, as adopted by AHJ, California Plumbing Code.
9. San Mateo County Community College District Design Standards: Basic Fire Protection System Design.
10. UL Fire Protection Equipment Directory.
11. UL Online Certifications Directory.
12. FM Global Approval Guide.
13. NFPA 13, as adopted by AHJ, Standard for the Installation of Sprinkler Systems.
14. NFPA 14, as adopted by AHJ, *Standpipe and Hose Systems.*
15. NFPA 20, Latest Edition, Installation of Stationary Pumps.
16. NFPA 24, Latest Edition, Standard for the Installation of Private Fire Service Mains and Their Appurtenances.
17. NFPA 25, Latest Edition, Standard for Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.
18. NFPA 291, Latest Edition, Recommended Practice for Fire Flow Testing and Marking of Hydrants.

F. Permits and Inspections:
1. Unless otherwise distinctly hereinafter specified, apply and pay for necessary permits, plans check, and inspections required by public AHJ.
2. Refer to General and Supplementary Conditions for payment of water service connection fees.

3. Obtain certificates of inspection from AHJs and deliver to Owner before final acceptance.
4. Each trade to consult local building department, fire department and utility companies prior to commencement of work to ascertain existence and location of existing underground utilities. Protect existing service against damage and interruption of use, and reroute as may be necessary to accomplish new work. Include costs for materials and installation for rerouting as specified for new work in bid price.

G. Material and Equipment: Listed for its intended fire suppression use in current UL Fire Protection Equipment Directory, or UL Online Certifications Directory for Fire Protection, or FM Global Approval Guide.

## 1.6 SEQUENCING AND SCHEDULING

A. For proper execution of work cooperate with other trades as needed.

B. To avoid installation conflicts, thoroughly examine complete set of Contract Documents. Resolve conflicts with Architect prior to fabrication and installation.

C. Prior to installation of equipment requiring electrical connections, examine manufacturer's shop drawings, wiring diagrams, product data, and installation instructions. Verify that electrical characteristics indicated in Contract Documents are consistent with electrical characteristics of actual equipment being installed. When inconsistencies occur request clarification from Architect.

## 1.7 COORDINATION DOCUMENTS

A. Prior to construction, coordinate installation and location of piping, fire sprinklers, standpipes, fire pumps, controllers and electrical services with architectural and structural requirements, and other trades (including plumbing, HVAC equipment, ductwork, grilles, diffusers, electrical, lights, ceiling suspension, and tile systems), and provide reasonable maintenance access requirements.

B. Where pipes pass through walls/floors/ceilings and structural members, verify the openings with structural engineer.

## 1.8 EXISTING SOILS CONDITIONS

A. Understand existing soils conditions before submitting bid on work. No additional allowance will be granted due to lack of information for existing conditions of subsurface soils.

B. Submission of a bid will be considered acknowledgment of review/understanding of project geotechnical soils report.

# PART 2 - PRODUCTS

## 2.1 HAZARDOUS MATERIALS

A. Do not use products containing asbestos, lead, arsenic, or any other material defined by EPA as hazardous to human or animal life.

## 2.2 MATERIALS

A. Base contract upon furnishing materials as specified. Materials, equipment, and

sprinklers used for construction are to be new, the latest products as listed in manufacturer's printed catalog data and are to be UL or CSA approved or acceptable by state, county, and city authorities. Equipment supplier is responsible for obtaining state, county, and city acceptance on equipment not UL approved or not listed for installation.

B. Materials, sprinklers, and equipment of a kind to be standard product of one manufacturer and of current manufacture.

C. Names and manufacturer's names denote character and quality of equipment desired and are not to be construed as limiting competition.

## PART 3 - EXECUTION

### 3.1 ACCESSIBILITY AND INSTALLATION

A. Install equipment having components requiring access (i.e., drains, valves, motors, engines, controllers, air compressors, gauges, fill cups, tanks, drives, and the like) so that they may be serviced, reset, replaced or recalibrated and the like, by service people with normal service tools and equipment. Notify Architect in writing if equipment or components are shown in such a position that above cannot be accomplished.

B. Install equipment complete as directed by manufacturer's installation instructions. Obtain installation instructions from manufacturer prior to rough-in of equipment, examine instructions thoroughly. When requirements of installation instructions conflict with Contract Documents, request clarification from Architect prior to proceeding with installation. This includes proper installation methods and sequencing, in coordination with other trades and disciplines.

C. Earthwork:
1. Refer to Division 31.
2. Perform excavation and backfill for installation of fire suppression work.

D. Firestopping:
1. Coordinate with Drawings location of fire rated walls, ceilings, floors and the like. When these assemblies are penetrated, seal around piping, ductwork, equipment, and the like, with approved firestopping material.
2. Install firestopping material complete as directed by manufacturer's installation instructions. Meet requirements of ASTM E814.

### 3.2 NOISE AND VIBRATION

A. Install vibration isolators and measures required to prevent noise and vibration from being transmitted to occupied areas. Select equipment to operate within noise coefficient (NC) design level for particular type of installation in relation to its location.

B. After installation, make proper adjustments to reduce noise and vibration to acceptable levels as defined by Architect.

### 3.3 SEISMIC CONTROL

A. Provide the following:
1. General:
   a. Earthquake resistant designs for mechanical equipment, i.e., standpipes, pumps, tanks, fire suppression piping, to conform to regulations of CBC.
   b. Restraints which are used to prevent disruption of function of piece of equipment because of application of horizontal force to be such that

forces are carried to frame of structure in such a way that frame will not be deflected when apparatus is attached to a mounting base and equipment pad, or to structure in normal way, utilizing attachments provided. Secure equipment, piping, and the like, to withstand a force in direction equal to value defined in CBC.

c. Retain licensed structural engineer to provide shop drawings of seismic bracing and seismic movement assemblies for piping/tanks/pumps, and the like. Engineer to design and provide stamped shop drawings for equipment, tanks, pumps, piping seismic bracing, and the like. Submit shop drawings along with equipment submittals.

d. Retain licensed structural engineer to provide shop drawings of seismic flexible joints for piping and the like crossing building expansion or seismic joints. Engineer to design and provide stamped shop drawings for piping flexible seismic joints. Coordinate actual design deflection or travel with project structural engineer. Submit shop drawings along with seismic bracing details. Coordinate exact design requirements from project structural engineer.

2. Piping:
   a. Use sway brace requirements of CBC and NFPA 13.
   b. As approved by code authority, use a bracing system manufactured by Tolco, Afcon, or approved.
3. Equipment:
   a. Provide sway bracing to prohibit excessive motion of fire suppression equipment and piping during earthquake.
   b. Provide fire suppression equipment and piping, both hanging and base mounted, with mounting connection points of sufficient strength to resist lateral seismic forces equal to 0.5 of equipment operating weight or lateral seismic forces as determined by building code calculations, whichever is more demanding.

## 3.4 REVIEW BY ENGINEER

A. Notify Architect/Engineer, in writing, at following stages of construction so that Architect/Engineer may, at their option, visit site for review and construction observation:
   1. Fire Suppression:
      a. Underground piping installation prior to backfilling.
      b. When ceiling installation is started.
      c. When mains or branchlines are to be permanently concealed by construction or insulation systems.
      d. When fire suppression systems, or portions of, are being tested and ready for inspection by AHJ.

## 3.5 OPERATING DURING CHANGEOVER

A. During remodeling of existing structure, or addition of a structure to existing structure, while existing structure is occupied, present services to remain intact until new construction, facilities or equipment is installed.

B. Prior to changing over to new service, verify that every item is thoroughly prepared. Install new piping, wiring, and the like, to point of connection.

C. Perform actual transfer to new service at off-peak time, as coordinated with Owner. Once changeover is started, pursue it to its completion, to keep interference to a minimum.

D. During changeover, for the entire time system, or part thereof, is not operational, provide a fire watch, including a watchperson whose sole duty is to watch for and report fires.

## 3.6 MUTILATION

A. Repair mutilation of building around pipes, equipment, hangers, braces, and the like.

## 3.7 DEMOLITION

A. Scope:
1. It is intent of these documents to provide necessary information and adjustments to fire suppression system required to meet code, and accommodate installation of new work.
2. Coordinate with Owner so that work can be scheduled not to interrupt operations, normal activities, building access, access to different areas.
3. Existing Conditions: Determine exact location of existing utilities and equipment before commencing work, compensate Owner for damages caused by failure to exactly locate and preserve underground utilities. Replace damaged items with new material to match existing. Promptly notify Owner if utilities are found which are not shown on Drawings.

B. Equipment: Unless otherwise directed, equipment, piping or fittings being removed as part of the demolition process are the Owner's property. Remove other items not scheduled to be reused or relocated from job site as directed by Owner.

C. Unless specifically indicated on the Drawings, the Contractor shall remove all unused piping to behind finished surfaces (floor, walls, ceilings, etc.). Cap piping and patch surfaces to match surrounding finish.

D. Unless specifically indicated on the Drawings, the Contractor shall remove all unused equipment, fixtures, rough-ins, connectors, etc. Removal is to be to a point behind finished surfaces (floors, walls, ceilings, etc.).

## 3.8 ELECTRICAL INTERLOCKS

A. Where equipment motors are to be electrically interlocked with other equipment for simultaneous operation, utilize mechanical equipment wiring diagrams to coordinate with electrical systems so that proper wiring of equipment involved is affected.

## 3.9 EQUIPMENT SELECTION AND SERVICEABILITY

A. Replace or reposition equipment which is too large or located incorrectly to permit servicing, at no additional cost to Owner.

B. Maintain design intent where equipment other than as shown in Contract Documents is provided. Where equipment requires piping arrangement, control diagrams, or sequencing different from that indicated in Contract Documents, provide electrical motors, wiring, controls, or other required electrical components at no additional cost to Owner.

## 3.10 DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle materials and equipment in a manner to prevent damage and deterioration. Store in original container which identifies manufacturer's name, brand and model number. Do not store indoor equipment outdoors unless provided with a waterproof protective cover.

B. Replacement: In event of damage, immediately make necessary repairs and replacements.

## 3.11 DEMONSTRATION

A. Upon completion of work and adjustment of equipment, test systems to demonstrate to Owner's Representative and Architect that equipment furnished and installed or connected under provisions of these Specifications functions mechanically in manner required.

B. Manufacturer's Field Services: Furnish services of a qualified person for a period of not less than 4 hours, at a time approved by Owner, to instruct maintenance personnel, correct defects or deficiencies, and demonstrate to satisfaction of Owner that entire system is operating in a satisfactory manner and complies with requirements of other trades or Contractors that may be required to complete work. Complete instruction and demonstration prior to final job site observations.

## 3.12 CLEANING

A. Upon completion of installation, thoroughly clean exposed portions of equipment, removing temporary labels and traces of foreign substances. Throughout work, remove construction debris and surplus materials accumulated by this work.

## 3.13 INSTALLATION

A. Install equipment and piping in accordance with manufacturer's installation instructions, plumb and level except where required to be pitched. Maintain manufacturer's recommended clearances.

B. Start up equipment, in accordance with manufacturer's start-up instructions, and in presence of manufacturer's representative. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

## 3.14 CUTTING AND PATCHING

A. Refer to Division 1 for "Cutting and Patching."

## 3.15 ACCEPTANCE

A. System can not be considered for acceptance until work is completed and demonstrated to Architect that installation is in strict compliance with Specifications, Drawings and manufacturer's installation instructions, particularly in reference to following:

1. Testing reports including Contractor's Material and Test Certificate for Underground Piping, Contractor's Material and Test Certificate for Aboveground Piping, Contractor's Material and Test Certificate for Private Fire Service Mains, Fire pump acceptance test data report, and the like.
2. Cleaning.
3. Final acceptance by AHJ.
4. Operating and Maintenance Manuals.
5. Training of operating personnel.
6. Record Drawings.
7. Guaranty certificates.
8. Start-up and test document.
9. Letter of conformance.

## 3.16 LETTER OF CONFORMANCE

A. Provide letter of conformance and copies of manufacturers' warranties and extended warranties with a statement in letter that mechanical items were installed in accordance with manufacturer's recommendations. Include letter of conformance and copies of

manufacturers' warranties and extended warranties in operating and maintenance manuals.

B. Warranties to begin at date of substantial completion.

**END OF SECTION**

# SECTION 21 01 00

# BASIC FIRE SUPPRESSION MATERIALS AND METHODS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Work Included:
1. Materials, installation and testing of pipe, tubing, sprinklers, fittings, and valves.
2. Refer to Specification Sections for each system medium (i.e., standpipe and hose, fire suppression sprinkler systems, fire pumps, storage tanks for fire suppression, and the like) for product application.
3. Motors and starters.
4. Hanging and bracing.
5. Switches and supervisory devices.
6. Fire suppression identification materials.
7. Vibration and noise isolation.
8. Provide electrical connections and wiring as required for a complete and operable system. Includes, but is not limited to air compressors, sump pumps, fire pumps, jockey pumps, pump controllers, and the like.

### 1.2 QUALITY ASSURANCE

A. Manufacturer's Inspection: Inspect flanges, fittings and field applied welds in accordance with manufacturer's standard written quality control procedure in accordance with the following techniques: Visual Method: Comply with MSS SP-55 except as otherwise indicated.

B. Welding Qualification: Qualify welding procedures, welders and operators in accordance with ANSI B31.1 for shop and project site welding of piping work.

### 1.3 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data, installation instructions, and dimensioned drawings for:
1. Access panels.
2. Each type of:
   a. Pipe for underground and aboveground systems.
   b. Fitting: flanged, welded, mechanical, threaded gasket.
   c. Coupling.
   d. Attachment: Concrete anchor, lag screw, through-bolt, and the like.
   e. Sprinkler: Upright, pendent, sidewall, special, and the like.
   f. Sprinkler guard.
   g. Sprinkler escutcheon.
   h. Spare sprinkler box.
   i. Sway Bracing: Fittings, attachment, pipe, angle iron, and the like..
   j. Gauge.
   k. Fire department connection.
   l. Waterflow detector.
   m. Supervisory switch.
   n. Pressure switch.
   o. Meter: Water, flow, detector.
   p. Inspector's test connection.
   q. Alarm Bell: Electric and water motor activated.

r. Valve: Butterfly, rising stem gate, non-rising stem gate, globe, ball, drain, angle, automatic ball drip, check, backflow preventer, reduced-pressure backflow preventer, pressure relief, alarm, hydrant, testing, riser, sectional, fill, solenoid, and the like.
s. Control panel: fire pump, jockey pump, alarm, and the like.
t. Sign.
u. Hose cabinet.
v. Hose.
w. Nozzle.
x. Pump: Fire, jockey, sump, and the like.
y. Fire caulking.
z. Access panel.
aa. Miscellaneous: Solder, flux, glue, brazing filler.

B. Piping Materials List: Provide a typewritten list which schedules the piping materials to be used for each system as a function of applicable nominal pipe size ranges. Arrange schedule in outline form for each specific piping system, e.g., "Fire Sprinkler System," "Standpipe and Hose System," "Sway Bracing System," and the like. Include ASTM, ANSI, UL, FM Global or other numbers and other data as necessary to demonstrate compliance with requirements.

C. Test Procedure: Submit a typewritten checklist type of testing procedure indicating testing medium (i.e., water, air, nitrogen, and the like), pipe service, pipe and fitting type and classification, test pressure, pass/fail criteria and other pertinent data.

D. Maintenance Data: Submit maintenance data and parts list for each type valve. Include this data, product data, and certifications in operations and maintenance manual.

## PART 2 - PRODUCTS

### 2.1 PRODUCT STANDARDS

A. Material and Equipment: Listed for its intended use in current UL Fire Protection Equipment Directory, or UL Online Certifications Directory for Fire Protection, or FM Global Approval Guide, new and of current manufacture.

B. Where pressures are expected to exceed 175 PSI due to pressure regulating valve failure, provide products for high pressure or extra high pressure service.

C. Provide per AHJ requirements.

D. References to product Specifications for materials are listed according to accepted base standards. Materials to meet latest approved versions of these standards.

E. See Section 21 00 00, Basic Fire Suppression where piping materials are approved for use.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. General Electrical Equipment Clearances: Do not route piping through electrical rooms, transformer vaults, elevator equipment rooms, and other electrical or electronic equipment spaces and enclosures. Within equipment rooms, provide minimum 3-foot lateral clearance from sides of electric switchgear panels. Do not route piping above

electric power or lighting panel, switchgear, or similar electric device. Coordinate with electrical and coordinate exact pipe routing to provide proper clearance with such items.

B. Pressure Piping Routing:
1. Route piping, except as otherwise indicated, vertically and horizontally (sloped to drain). Avoid diagonal runs wherever possible. Orient horizontal routes parallel with walls and beam lines.
2. Install piping as shown or described by diagrams, details and notations on Drawings or, if not indicated, install piping to provide the shortest route which does not obstruct usable space or block access for servicing the building and its equipment.
3. Support piping adjacent to walls, overhead construction, columns and other structural and permanent enclosure elements of the building. Limit clearance to 2 inches wherever furring is indicated for concealment of piping. Allow for insulation thickness. Locate insulated piping to provide minimum 1-inch clearance outside insulation.
4. Wherever possible in finished and occupied spaces, conceal piping from view by locating within column or beam enclosures, hollow wall construction, or above suspended ceilings. Do not encase horizontal routes in solid partitions, except where approved.

C. Preparation:
1. Insulating (Dielectric) Unions: Comply with manufacturer's instructions for installing unions wherever piping of dissimilar metals are adjoined. Install unions in manner which will prevent galvanic action and inhibit corrosion.
2. Couplings: Install where indicated on Drawings and on each side of pieces of equipment to permit easy removal of equipment.
3. Copper Tubing:
   a. Remove burrs from and clean outer surface of tube ends and inner surface of fittings.
   b. Copper-Soldered: Make soldered joints for copper tubing and fittings with code approved solder alloys meeting NFPA, ASTM and ANSI standards and listings. Solder-paste-flux combination fillers are not approved. Installations to conform to accepted published procedures; i.e., NFPA, UPC IS 375, IS 21-80 standards and CDA Publications. Use of steel wool for cleaning tube and fittings is prohibited. Apply flux as recommended by manufacturer. Solder fire suppression pipe within building above grade with 95 percent tin and 5 percent antimony, Allstate Silver Bearing Solder 430 or other approved solder alloys which do not contain lead or cadmium.
   c. Copper-Brazed: Make brazed joints for copper tubing and fittings with code approved brazing filler alloys meeting NFPA, ASTM and AWS standards and listings. Filler alloys of BCuP2 classification (e.g., "Phos-0" or "Fos-Copper") may not be used to make joints between copper tubing and cast brass or bronze fittings. Filler alloys containing cadmium are not approved for use in fire suppression water piping. Installations to conform to accepted published procedures, i.e., NFPA, UPC IS 3-75 standards and CDA Publications. Use of steel wool for cleaning tube and fittings is prohibited. Braze other copper pressure piping underground including water service. Remove bonnets and nonmetallic seats on valves and cool body with damp cloth while soldering or brazing. Remove excess flux from completed joints in accordance with manufacturer's instructions and code standards.
   d. Pressurized Service:
      1) Unless otherwise indicated, wrought copper/bronze solder joint fittings complying with ANSI B16.22-1995.
      2) Copper Tube Unions: Standard products as recommended by

manufacturer for use in the service. Rated at 150 percent design operating pressure.

3) Mechanically Formed Tee Connections:
   a) Form mechanically extracted collars in a continuous operation consisting of drilling a pilot hole and drawing out the tube surface to form a collar having a height of not less than three times the thickness of the tube wall. Fully adjustable collaring device to ensure proper tolerance and complete uniformity of the joint.
   b) Notch the branch to conform with the inner curve of the run tube and dimpled to ensure penetration of the branch tube into the collar is of sufficient depth for brazing and that the branch tube does not obstruct the flow in the main line tube.
   c) Braze joints in accordance with the Copper Development Association Copper Tube Handbook using B-cup series filler metal. Note: Soft soldered joints will not be permitted.

e. Steel and Copper: Deburr cut edges.

D. Install products per UL listing or FM approval and per manufacturer's instructions.

## 3.2 PIPE AND PIPE FITTINGS

A. Pipe Sleeves:
1. Lay out work in advance of pouring concrete and furnish and set sleeves necessary to complete work.
2. Floor Sleeves: Provide sleeves on pipes passing through concrete or masonry construction. Extend sleeve 1 inch above finished floor. Caulk pipes passing through floor with nonshrinking grout or approved caulking compound. Provide "Link-Seal" sleeve sealing system for slab on grade. Caulk/seal piping passing through fire rated building assembly with UL rated assemblies. Provide fire-rated assemblies per local AHJ requirements.
3. Wall Sleeves: Provide sleeves on pipes passing through concrete or masonry construction. Provide sleeve flush with finished face of wall. Caulk pipes passing through walls with nonshrinking caulking compound. Caulk/seal piping passing through fire-rated building assemblies with UL Listed or FM Approved fire-rated firestopping compound. Provide fire-rated assemblies per local AHJ requirements.
4. Beam Sleeves: Coordinate with trades for locations of pipe sleeves in reinforced concrete and steel beams. Penetrations must be indicated on structural shop drawings. See Drawings and Specifications for specific sleeve location limitations. Plumbing drawings are diagrammatic. Offset piping as required to meet these limitations. Pipe sleeve locations must be indicated on reinforced concrete and steel beam shop drawings. Field cutting of beams not allowed without written approval of structural engineer. No extra costs allowed for failure to coordinate beam penetrations prior to reinforced concrete and steel beam shop drawing submittal.

B. Conform with applicable codes and industry standards.

C. Install uninsulated piping so that unrestrained direct contact with the structure or other system installations is avoided. Where contact with or passage through building or structural features cannot be avoided; firmly anchor piping to, or isolated from, the structure to prevent noise transmission and occurrence of physical damage. Install piping to be insulated with adequate clearance around piping to allow for placement of full thickness insulating material.

D. Underground Steel Piping Corrosion Protection: Factory wrap uninsulated underground galvanized steel fire department connection piping systems with protective coating composed of a coal-tar saturated wrapping tape over a 20 mil thick coal-tar epoxy coating, equivalent to "Republic X-Tru-Coat." Wrap joints spirally with a minimum overlap of 1/2 tape width. Extend wrap not less than 3 inches above grade. Provide tinker test to check for holidays. Provide cathodic protection to meet requirements of governing authorities and servicing utility.

E. Expansion and Flexibility: Install work with due regard for expansion and contraction to prevent damage to the piping, equipment, building and its contents. Provide piping offsets, loops, approved type expansion joints, sway bracing, wire restraints, vertical restraints, flexible couplings or other means to control pipe movement and to minimize pipe forces.

F. Install piping in concealed spaces above finished ceilings. Obtain Architect's and Engineer's approval of exposed piping prior to installation.

G. Coordinate support of pipe 4 inches and larger with structural engineer.

H. Provide clearances around piping per NFPA 13.

I. Coordinate installation with other trades. Route piping as required to avoid building structure, equipment, plumbing piping, HVAC piping, ductwork, lighting fixtures, electrical conduits and bus ducts and similar work. Final location of lighting will have priority over final sprinkler locations. Provide drains to trapped sections of system which result from such routing. Other trades take precedence for installation space.

## 3.3 ESCUTCHEONS

A. Install on exposed pipes passing through walls or floors.

## 3.4 PIPING AND EQUIPMENT REMOVAL

A. Piping and equipment removed as salvage by Owner to remain property of the Owner.

B. Comply with Division 02, Section "Selective Structure Demolition."

C. Remove as shown on drawings. Piping to be reused where shown. Dispose and remove excess piping equipment (and not identified by Owner as salvage).

## 3.5 ACCESSIBILITY

A. Installation of valves, gauges and equipment conveniently and accessibly located with reference to finished building for repairs, removal and service.

B. Access Panels: Label access panels with engraved nameplates indicating function of panel. Seton, Bakelite or approved. Nameplates to have 1/4-inch high white letters on red background, unless noted otherwise.

## 3.6 PAINTING

A. Machinery:
1. In a mechanical room, on the roof or other exposed areas, piping and equipment except sprinklers to receive two coats of primer and one coat of rustproof enamel, colors as selected by Architect.
2. See individual equipment specifications for other painting.

B. Structural Steel: Repair damage to structural steel finishes or the finishes of other materials damaged by cutting, welding or patching to match original.

C. Piping: Clean, primer coat, and paint exposed piping on the roof or at other exterior locations with two coats of paint suitable for metallic surfaces and exterior exposures. Color selected by Architect.

## 3.7 ACCESS PANELS

A. Install ceiling or wall access panels to provide access to concealed valves, drains, drum drips, test connections and other fire suppression items needing service. Provide access panels at locations required or as specified herein. Coordinate locations/sizes of access panels with Architect prior to work.

B. Where access panels are for service of valves, test connections, auxiliary drains, stencil the words "Fire Valve," "Inspector's Test Connection" or "Fire Auxiliary Drain " in 1/2-inch high capital letters on the outside of the panels.

## 3.8 FIRESTOPPING PENETRATIONS IN FIRE-RATED WALL/FLOOR ASSEMBLIES

A. Provide proper sizing when providing sleeves or core-drilled holes to accommodate the penetration. Firestop voids between sleeve or core-drilled hole and pipe passing through to meet the requirements of ASTM E814 and NFPA.

B. Manufacturers: Hilti, Firetemp, or approved.

## 3.9 FIELD QUALITY CONTROL

A. Upon completion of installation of equipment, sprinklers, hose valves and piping and after units are water pressurized, test system to demonstrate capability and compliance with requirements. When possible, correct malfunctioning items at site, then retest to demonstrate compliance; otherwise, remove and replace with new items and proceed with retesting.

B. Inspect each installed item for damage to finish. If feasible, restore and match finish to original, except fire sprinklers, at site; otherwise, remove item and replace with new item. Feasibility and match to be judged by Architect. Remove cracked or dented items and replace with new items.

C. Fire sprinklers may not be reused, or cleaned, except for dusting. Replace damaged, field painted, oversprayed, overcoated or field coated sprinklers with new sprinklers of same manufacturer, model, finish, K-factor and performance characteristics. Where identical replacement sprinklers are not available, provide sprinklers of similar finish, style, K-factor and performance characteristics.

## 3.10 VALVE INSTALLATION

A. Install valves where required for proper operation, testing and drainage. Locate valves so as to be accessible and so that separate support can be provided when necessary.

B. Installation of Check Valves:
1. Swing Check Valves: Install in horizontal position with hinge pin horizontally perpendicular to centerline of pipe. Install for proper direction of flow.
2. Wafer Check Valves: Install between two flanges in horizontal or vertical position, position for proper direction of flow.

C. Provide post indicator on buried control valves.

D. Provide listed backflow assembly at sprinkler system water source connection. Coordinate with local utility; conform to their installation requirements.

## 3.11 VALVE ADJUSTING AND CLEANING

A. Inspect valves for leaks. Adjust or replace packing to stop leaks. Replace valve if leak persists.

## 3.12 VALVE IDENTIFICATION

A. General: Provide valve tag on every valve and control device in each piping system. Exclude check valves and valves within factory fabricated equipment units. List each tagged valve in valve schedule for each piping system.

B. Drain, Auxiliary Drain and Drum Drips: Provide valve tag on every valve in each fire suppression system. List each tagged valve and its location in valve schedule, identify on fire suppression drawings.

C. Install framed, glass or rigid transparent plastic covered, mounted valve schedule and valve location drawing in main riser or fire pump room.

D. Provide identification sign on ceiling tile below valve location.

## 3.13 MECHANICAL EQUIPMENT IDENTIFICATION

A. General: Install engraved plastic laminate sign or plastic equipment marker on or near each item of fire suppression equipment and each operational device, as specified herein if not otherwise specified for each item or device. Provide signs for the following general categories of equipment and operational devices: valves, drains, pumps, standpipes, tanks, similar equipment.

## 3.14 ADJUSTING AND CLEANING

A. Adjusting: Relocate fire suppression identification device which has become visually blocked.

B. Cleaning: Clean face of identification devices, and glass frames of valve charts.

## 3.15 CONNECTIONS TO EXISTING

A. Prior to connection of piping to existing as illustrated on Plumbing Drawings, field verify existing conditions and exact sizes and locations of existing piping and ductwork. Provide additional offsets, transitions, joints, cut-ins, and replace portions of existing as required to facilitate connections of new as shown on Documents.

## 3.16 CAULKING

A. Provide Hilti FS-One High-Performance FireStop Sealant. ASTM E84-96, ICBO approved, Report No. ER-5071. Apply per manufacturer's recommendations.

## 3.17 FIRE DEPARTMENT CONNECTION

A. Fire Department Connection: Locate with sufficient clearance from walls, obstructions, or adjacent siamese connectors to allow full swing of fire department wrench handle. Provide method of draining FDC piping.

## 3.18 TEST CONNECTIONS

A. Route water supply flow test connections to a location which can accept the flow under wide-open flow and pressure for a sufficient time to assure a proper test, and which will not cause damage, including to landscaping.

## 3.19 COORDINATION

A. Coordinate location and electrical requirements for compressors, fire pumps, sump pumps, jockey pumps, pump controllers, heater cables, valve tamper switches, pressure switches, flow switches, alarm bells, pre-action system components and the like with Division 26.

## 3.20 CALCULATIONS

A. Hydraulic calculations include friction losses between the hydraulically most remote design area and the hydrant flow test pressure hydrant.

## 3.21 DRAINS

A. Locate drain connections within 7 feet of floor. Provide piping capable of being fully drained.

## 3.22 BELLS

A. Locate exterior alarm bells at 8 feet above finished grade. Coordinate with Architect.

## 3.23 FIELD SERVICES

A. Instruct the Owner in the operation of the sprinkler system, including main valve position (open or closed) recognition, system drainage, system testing, and the relation to the fire alarm system.

## 3.24 THERMAL EXPANSION/CONTRACTION

A. On shop drawings, show loops for expansion or contraction where piping is subjected to thermal expansion/contraction.

**END OF SECTION**

# SECTION 21 06 10

# SCHEDULES FOR WATER-BASED FIRE-SUPPRESSION PIPING AND EQUIPMENT

## PART 1 - GENERAL

### 1.1 GENERAL

A. Material and Equipment: Listed for its intended use in current UL Fire Protection Equipment Directory, or UL Online Certifications Directory for Fire Protection, or FM Global Approval Guide, new and of current manufacture.

B. Refer to Specification Sections for each system medium (i.e., standpipe and hose, fire suppression sprinkler systems, fire pumps, and the like) for product application.

## PART 2 - PRODUCTS

### 2.1 PIPE AND FITTINGS

A. General: Provide per AHJ requirements, and as a minimum per section 21 06 10 Schedules for Fire Suppression.

B. Where pressures are expected to exceed 175 PSI due to pressure regulating valve failure, provide products for high pressure or extra high pressure service.

C. Materials: Domestic Manufacture.

### 2.2 PIPE AND FITTINGS FOR SPRINKLERS, STANDPIPES AND FIRE PUMP SYSTEMS

A. Buried Piping: Ductile iron Class 52, AWWA C151 or PVC, SDR-18, AWWA C900.

B. Aboveground Inside Building Piping:
1. Pipe Size 2-Inch Diameter and Smaller: ASTM A53, ASTM A135, or ASTM A795; minimum CRR of 1.00 per UL listing or FM Global approval. Allied BLT/XL is not permitted.
2. Pipe Size 2-1/2-Inch Diameter and Larger: ASTM A53, ASTM A135, or ASTM A795; minimum CRR of 1.00 per UL Testing or FM Global approved, wall thickness greater than Schedule 5 (Schedule 5 not approved).

C. Copper Pipe: ASTM B75, ASTM B88, ASTM B251. Threaded, brazed, solder or mechanical fittings only.

D. Mechanical Couplings: FM Global approved; Victaulic, Gruvlok, or approved.

E. Mechanical Gaskets: EPDM, Vic-Plus, Grade E+, or approved.

F. In-Building Riser: single extended 90 degree fitting of fabricated stainless steel tubing, maximum working pressure 175 psi. Grooved-end connection on building outlet side and CIPS coupler on underground inlet side. Ames In-Building Riser, or approved.

G. Expansion Loop: Two flexible sections for hose and braid. Metraflex FireLoop, or approved.

## 2.3 VALVES FOR SPRINKLERS, STANDPIPES AND FIRE PUMP SYSTEMS

A. OS&Y Gate:
   1. 2-1/2 Inches and Larger: Iron body. Nibco F-607-0, or approved.
   2. 2 Inches and Smaller: Bronze. Nibco T-104, or approved.

B. NRS Gate: Non-rising stem with indicator post. Nibco M/F-609 with NIP1A or equivalent for yard use and Nibco NIP2 or equivalent for wall use.

C. Swing Check: Iron body, rubber and bronze faced checks. Nibco F-908-W, or approved.

D. Wafer Check: Iron body, rubber seat, spring actuated. Nibco W-900-W, or approved.

E. Butterfly Valves: Ductile iron body, Nibco WD3510-8 with factory-installed tamper switches or approved. Use lug body next to pumps, LD-3510-6 or approved.

F. Pressure Relief for Grid System: Bronze body, stainless steel spring. Watts FP-53L, United Brass Works 132, or approved.

G. Indicator Posts: Pit mounting type, regular target type or wall target type. Kennedy, Nibco, or approved.

## 2.4 SPECIALTY PRODUCTS FOR SPRINKLER, STANDPIPE AND FIRE PUMP SYSTEMS

A. Pressure Gauges: 3.5-inch, Bourdon tube or spring type, 0 to 300 PSI. Ashcroft 1005P-XUL, US Gauge 1590K, or approved,

B. Waterflow Alarm Switch: Pressure actuated with SPDT electrical switches and adjustable time delay (0 to 75 seconds). Potter WFSR-F, or approved.

C. Waterflow Detector: Vane-type; SPDT switches; adjustable time delay (0 to 75 seconds). Potter VSR-F, or approved.

D. Supervisory Switches: Compatible with valve (OS&Y gate, butterfly, or PIV); SPDT switches. Potter, or approved.

E. Alarm Bells - Exterior: Minimum 90 dBA at 10 feet. Potter PB 8-inch, or approved.

F. Automatic Ball Drip Valve: Bronze, spring-type. Tyco F789, or approved.

G. Sway Bracing: From one m**anufacturer. Tolco, Afcon, or approved.**

## 2.5 HOSE STATION

A. Vertical breakaway peg type, Sierra XGT1, or approved.

B. Hose: 1-1/2-inch diameter, synthetic, rubber lined, 100-foot length.

C. Nozzle: Plastic combination fog to straight stream with shutoff.

## PART 3 – EXECUTION

Not Used.

**END OF SECTION**

# SECTION 21 12 01

# FIRE SUPPRESSION STANDPIPES

## PART 1 - GENERAL

### 1.1 WORK INCLUDED

A. Provide the following:
1. Revise and relocate existing Class II automatic wet standpipe system.
2. Roof hydrant outlets.
3. Fire hose cabinets.
4. Fire hose racks.
5. Fire hose.

B. Coordinate with Section 21 13 00, Fire Suppression Sprinkler Systems.

## PART 2 - PRODUCTS

### 2.1 GENERAL

A. Refer to Specification Section 21 06 10 for additional product information.

### 2.2 FIRE-SUPPRESSION SCREW THREAD CONNECTIONS

A. Screw Thread Connections: Comply with local fire department/fire marshal regulations for sizes, threading and arrangement of connections for fire department equipment to standpipe systems.

### 2.3 FIRE-SUPPRESSION HOSES AND NOZZLES

A. Chrome plated; listed combination fog-straight stream and adjustable shut-off nozzle.

### 2.4 FIRE-SUPPRESSION HOSE RACKS

A. Polished chrome finish; swivel stationary type with pins and water stop.

### 2.5 FIRE-SUPPRESSION HOSE VALVES

A. Nonadjustable type, 2-1/2 inches nominal size with cap and chain on hose outlet.

### 2.6 FIRE-SUPPRESSION VALVE AND HOSE CABINETS

A. Formed steel finish painted; recessed. Door style: flush, hinged positive latch device, prepared for pipe and accessory rough-in.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. General:
1. Locate and secure hose cabinet plumb. Establish top of cabinet (inside horizontal) surface 60 inches above finished floor.
2. Connect wet standpipe system to water source ahead of domestic water

connection.

3. Provide additional drains as required to achieve proper drainage of the standpipe system.
4. Provide connection for alarm and supervisory control to building alarm system.

## 3.2 SYSTEM TEST

A. Hydrostatically test entire system in accordance with NFPA 14.

B. Witness test by fire marshal, AHJ, Owner's insurance underwriter, and Engineer.

**END OF SECTION**

# SECTION 21 13 00

# FIRE SUPPRESSION SPRINKLER SYSTEMS

## PART 1 - GENERAL

### 1.01 SUMMARY

A. This is a bidder design system. Contact Authority Having Jurisdiction (AHJ) prior to bid to verify fire system requirements. Provide design compliant with codes as interpreted by AHJ.

B. Provide the following:
1. New wet-pipe partial sprinkler system to protect Assembly Occupancies, including Multipurpose Room, Lobby and Cafeteria, Storage Rooms, Accessory spaces as required by code.
2. Provide a new private fire service main, including connection to existing utility, and piping to the inlet connection inside the building. Provide required valves, backflow preventer, vaults, and appurtenances.
3. Provide floor control stations, at each floor at the point of connection to the riser, controlling sprinklers on that floor. Floor control stations consist, at a minimum, of an indicating, supervised control valve, flow switch, pressure gauge, inspector's test connection and main drain connection.

C. Coordinate location and type of tamper, flow, and pressure switches, and the like with the fire alarm system.

D. Provide electrical connections and wiring as required for a complete and operable system. Includes, but is not limited to air compressors, fire pumps, jockey pumps, pump controllers, and the like.

E. Refer to Architectural, Structural, Mechanical, Plumbing, Electrical, and Civil Drawings for additional information relating to the fire sprinkler system

### 1.02 SYSTEM DESCRIPTION

A. Provide coverage building areas as indicated. Field verify field conditions prior to submittal of bid. Adjust bid to provide protection features in accordance with applicable codes and interpretations by AHJ. Provide design and installation based on the more stringent requirements if AHJ requirements differ from Code.

B. Design Parameters:
1. Building Area: Assembly areas, Multipurpose, Lobby, Cafeteria
   a. Occupancy Classification: Light.
   b. Density: 0.10 GPM per sq.ft. over a 1500 sq.ft. hydraulically most remote design area per NFPA 13.
   c. Inside Hose Allowance: 0 GPM.
   d. Outside Hose Allowance: 100 GPM.
2. Building Area: Storage Rooms, Accessory spaces as required by code.
   a. Occupancy Classification: Ordinary Group 2.
   b. Density: 0.20 GPM per sq.ft. over a 1500 sq.ft. hydraulically most remote design area per NFPA 13.
   c. Inside Hose Allowance: 0 GPM.
   d. Outside Hose Allowance: 250 GPM.
   e. Outside Hose Allowance: 100 GPM.
3. Design parameters above are NFPA 13 minimums. Provide increased design

densities, design areas, and hose allowances to meet requirements of AHJ.

C. Sprinkler system design to include a 10 percent pressure and flow cushion between system demand point and available water supplies.

D. Extend hydraulic calculations from hydraulically most remote design area back to location of pressure hydrant of flow test.

E. Develop cost-effective designs that may include the use of extended coverage sprinklers and design area reductions as allowed by NFPA 13.

## 1.03 REGULATORY REQUIREMENTS

A. The fire protection system requires Deferred Approval from Division of the State Architect. Project schedule shall allow for a 60 day DSA review cycle.

B. Fabrication of the fire protection system shall not be started until Contractor's Deferred Approval Submittal, including Shop Drawings, Specifications, and Engineering Calculations for the actual system to be installed have been accepted and signed by the Architect or Mechanical Engineer and approved by DSA.

## 1.03 FLOW TEST

A. Provide materials and labor for a new water supply test on the closest nearby fire hydrants per NFPA 13, and NFPA 291.

## 1.04 EXTRA STOCK

A. Provide extra sprinklers per code; provide suitable wrenches for each sprinkler type, and metal storage cabinet in riser room.

# PART 2 - PRODUCTS

## 2.01 GENERAL

A. Refer to Specification Section 21 06 10 for additional product information.

## 2.02 CONTROL VALVES

A. Sprinkler system control valves to be OS&Y or butterfly valves located inside building in 1-hour rated enclosure with outside door.

## 2.03 PIPE AND FITTINGS

A. Flexible Sprinkler Connectors: UL 2443. Fully welded, braided, leak tested sprinkler drop with a minimum internal corrugated hose diameter of 1-inch true-bore; and a one-piece ceiling bracket with removable attachment hub and self-securing integrated snap-on clip-ends, for attachment to a ceiling grid without the need for a screw fastener. Number of bends on flexible sprinkler connection fittings shall not exceed three. Minimum bend radius 3-inches. Flexhead.

## 2.04 SPECIALTY PRODUCTS

A. Inspector's Test Connection: Bronze, tamper and corrosion resistant orifice equivalent to smallest sprinkler orifice, sight flow connection. AGF TestAnDrain, or approved.

B. Floor Control Valve and Test Assembly: Control valve, water-flow alarm, sight glass, smooth bore orifice union of same size as smallest orifice sprinkler installed. Victaulic 747/747P, or approved.

## 2.05 SPRINKLERS

A. Finished Areas: Glass-bulb, recessed, quick-response pendent with white polyester finish, and white polyester escutcheon.

B. Nonfinished Areas: Glass-bulb, quick-response. Brass finish.

C. Dry: Recessed, glass bulb, quick-response, white polyester finish with chrome escutcheon.

D. Provide oversized escutcheons or flexible sprinkler connection fittings for pendent sprinklers to comply with building code and ASCE 7 seismic requirements for ceilings.

E. Provide guards for sprinklers located under ducts or other obstructions or for sprinklers located less than 8'-0" above finished floor or where subject to mechanical injury.

## 2.06 WET-PIPE SPRINKLER SYSTEMS

A. Hose Station: Sprinkler system design and hydraulic calculations to indicate point of connection to sprinkler piping.

# PART 3 - EXECUTION

## 3.01 INSTALLATION

A. Center sprinklers in the middle or quarter points of suspended ceiling tile.

B. Apply strippable tape or paper cover to ensure sprinklers do not receive field paint finish. Remove upon completion of painting.

C. Pendent sprinklers in areas subject to temperatures of greater than or less than 40F: Dry pendent type.

**END OF SECTION**

# SECTION 22 00 00

# PLUMBING REQUIREMENTS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Work Included: Work included in Section 22 00 00 applies to Division 22 work to provide materials, labor, tools, permits and incidentals to provide and make ready for Owner's use plumbing systems for proposed project.

B. Related Work Specified Elsewhere:
1. Contents of Section applies to Division 22 specifications.
2. Requirements of Section are a minimum for Division 22 Sections, unless otherwise stated in each Section, in which case that Section's requirements take precedence.

### 1.2 DEFINITIONS

A. Following is a list of abbreviations generally used in Division 22:

| | | |
|---|---|---|
| 1. | ADA | Americans with Disabilities Act |
| 2. | AHJ | Authority Having Jurisdiction |
| 3. | ANSI | American National Standards Institute |
| 4. | ARI | Air-Conditioning & Refrigeration Institute |
| 5. | ASHRAE | American Society of Heating, Refrigerating and Air-Conditioning Engineers |
| 6. | ASME | American Society of Mechanical Engineers |
| 7. | ASTM | American Society for Testing and Materials |
| 8. | ASSE | American Society of Sanitary Engineering |
| 9. | AWWA | American Water Works Association |
| 10. | CBC | California Building Code |
| 11. | CEC | California Electrical Code |
| 12. | CMC | California Mechanical Code |
| 13. | CPC | California Plumbing Code |
| 14. | CISPI | Cast Iron Soil Pipe Institute |
| 15. | CSA | Canadian Standards Association |
| 16. | ETL | Electric Testing Laboratories |
| 17. | FM | FM Global |
| 18. | HI | Hydraulic Institute Standards |
| 19. | HVAC | Heating, Ventilating and Air Conditioning |
| 20. | IBC | International Building Code, latest adopted version with State amendments as referenced in CBC. |
| 21. | IFC | International Fire Code. |
| 22. | IMC | International Mechanical Code. |
| 23. | LEED | Leadership in Energy and Environmental Design in Association Green Building Council |
| 24. | MSS | Manufacturers Standardization Society |
| 25. | NEC | National Electric Code |
| 26. | NEMA | National Electrical Manufacturers Association |
| 27. | NFPA | National Fire Protection Association |
| 28. | NRCA | National Roofing Contractors Association |
| 29. | NSF | National Sanitation Foundation. |
| 30. | OSHA | Occupational Safety and Health Administration |

| | | |
|---|---|---|
| 31. | SMACNA | Sheet Metal and Air Conditioning Contractors' National Association, Inc. |
| 32. | TEMA | Tubular Exchanger Manufacturers Association |
| 33. | TIMA | Thermal Insulation Manufacturers Association |
| 34. | UL | Underwriters Laboratories Inc. |
| 35. | UPC | Uniform Plumbing Code |

B. Provide: To furnish and install, complete and ready for the intended use.

C. Furnish: Supply and deliver to the project site, ready for unpacking, assembly and installation.

D. Install: Includes unloading, unpacking, assembling, erecting, installation, applying, finishing, protecting, cleaning and similar operations at the project site as required to complete items of work furnished by others.

## 1.3 ADDITIONAL REQUIREMENTS TO DIVISION 01

A. Operation and Maintenance Documentation: Copies of certificates of code authority acceptance, test data, parts lists, maintenance information for equipment, valves, balancing reports, and other special guarantees, certificates of warranties, and the like, specified elsewhere herein or indicated on Drawings.

B. Shop Drawings: Provide shop drawings which include physical characteristics, electrical characteristics, device layout plans, wiring diagrams, and the like. Refer to individual Specification Sections for additional requirements for the shop drawings.

C. Close-out Documentation: Submit plumbing code authority certification of inspection.

D. Record Drawings:
1. Show changes and deviations from the Drawings. Include issued Addendum and change order items.
2. Make changes to the Drawings in a neat, clean, and legible manner.

E. Product Data:
1. Submit manufacturer's technical data, installation instructions and dimensioned drawings for products, fixtures, equipment and devices installed, supplied or provided. Refer to individual specification sections for specific items required in product data submittal. Submit at one time in 3-ring binder, tabbed and referenced to match the Contract Documents.
2. Maintain an updated product submittal package to be included in the final operation and maintenance documentation.

## 1.4 QUALITY ASSURANCE

A. Where Contract Documents are at variance with applicable codes governing work, code and local jurisdiction requirements take precedence, and include cost necessary for code compliance or local jurisdiction compliance in bid price. Machinery and equipment to comply with Occupational Safety and Health Act of 1970, as currently revised, as interpreted for equipment manufacturer requirements.

B. Plumbing Drawings: Drawings are intended to be diagrammatic and are based on one manufacturer's equipment. They are not intended to show every item in its exact dimensions, or details of equipment or proposed systems layout. Verify actual dimensions of systems (i.e., piping) and equipment proposed to assure that systems and equipment will fit in available space. Contractor is responsible for design and construction costs incurred for equipment other than basis of design, including but not limited to architectural, structural, electrical, HVAC, fire sprinkler, and plumbing.

C. Requirements: As a minimum requirement, work in accordance with following rules and regulations and applicable laws:
1. NFPA.
2. OSHA.
3. Codes as published by ICBO:
   a. IBC.
   b. IFC.
   c. IMC.
   d. IPC.
4. UPC.
5. Related supplements and standards.
6. California State Energy Code.
7. CBC California Building Code.
8. CMC California Mechanical Code.
9. CPC California Plumbing Code.
10. State of California and local jurisdictional requirements.

D. Permits and Inspections:
1. Unless otherwise distinctly hereinafter specified, apply and pay for necessary permits, plans check, and inspections required by public AHJ.
2. Refer to General and Supplementary Conditions for payment of water and sewer service connection fees.
3. Obtain certificates of inspection from AHJs and deliver to Owner before final acceptance.
4. Each trade to consult local building department and utility companies prior to commencement of work to ascertain existence and location of existing underground utilities. Protect existing service against damage and interruption of use, and reroute as may be necessary to accomplish new work. Include costs for materials and installation for rerouting as specified for new work in bid price.

E. Regulatory Requirements:
1. UL and CSA Compliance: Provide units which are UL and CSA listed.
2. ASME Compliance: Provide units which are ASME listed when water heaters and boilers which exceed 200,000 BTUH, hot water storage tanks which exceed 120 gallons, and hot water expansion tanks which are connected to ASME rated equipment or required by code or local jurisdiction.
3. Provide safety controls required by National Boiler Code (CSD-1) for boilers and water heaters exceeding 400,000 BTUH.

## 1.5 SEQUENCING AND SCHEDULING

A. For proper execution of work cooperate with other trades as needed.

B. To avoid installation conflicts, thoroughly examine complete set of Contract Documents. Resolve conflicts with Architect prior to fabrication and installation.

C. Prior to installation of equipment requiring electrical connections, examine manufacturer's shop drawings, wiring diagrams, product data, and installation instructions. Verify that electrical characteristics indicated in Contract Documents are consistent with electrical characteristics of actual equipment being installed. When inconsistencies occur request clarification from Architect.

## 1.6 COORDINATION DOCUMENTS

A. Prepare and submit coordinated layout drawings, prior to construction, to coordinate installation and location of ductwork, grilles, diffusers, piping, fire sprinklers, plumbing, lights, and electrical services. Composite Drawings show services on single sheet. Key Drawings to structural column identification system, and progressively number. Prior to completion of Drawings, coordinate proposed installation with architectural and structural requirements, and other trades (including plumbing, HVAC, fire protection, electrical, ceiling suspension, and tile systems), and provide reasonable maintenance access requirements.

B. Prepare Drawings as follows:
1. Prepare Drawings to accurate scale of 1/4 inch = 1 foot or larger on Mylar sheets or AutoCAD. Drawings are to be same size as Contract Drawings and to indicate location, size and elevation above finished floor of plumbing equipment and piping. Drawings to also indicate proposed ceiling grid and lighting layout as shown on electrical drawings and reflected ceiling drawings.
2. Review and revise as necessary section cuts in Contract Drawings after verification of field conditions.
3. Indicate plumbing system piping including fittings, hangers, access panels, valves, and bottom of pipe elevations above finished floor.
4. Piping that must be graded to have right-of-way over more flexible items. Drawings also to indicate proposed ceiling grid and lighting layout as shown on electrical drawings and reflected ceiling drawings and HVAC equipment, ductwork and piping.
5. Drawings are to incorporate Addenda items and change orders.
6. Distribute drawings to trades and provide additional coordination as needed.

C. Advise Architect, in event a conflict occurs in location or connection of equipment. Bear costs resulting from failure to properly coordinate installation or failure to advise Architect of conflict.

D. Verify in field exact size, location, invert, and clearances regarding existing material, equipment and apparatus, and advise Architect of discrepancies between that indicated on Drawings and that existing in field prior to installation related thereto.

E. Final coordination drawings with appropriate information added to be submitted as Record Drawings at completion of project.

## 1.7 EXISTING SOILS CONDITIONS

A. Understand existing soils conditions before submitting bid on work. No additional allowance will be granted due to lack of information for existing conditions of subsurface soils.

B. Submission of a bid will be considered acknowledgment of review/understanding of project geotechnical soils report.

## PART 2 - PRODUCTS

### 2.1 HAZARDOUS MATERIALS

A. Do not use products containing asbestos, lead, arsenic, or any other material defined by EPA as hazardous to human or animal life.

### 2.2 MATERIALS

A. Base contract upon furnishing materials as specified. Materials, equipment, and fixtures used for construction are to be new, the latest products as listed in manufacturer's printed catalog data and are to be UL or CSA approved or acceptable by state, county, and city authorities. Equipment supplier is responsible for obtaining state, county, and city acceptance on equipment not UL approved or not listed for installation.

B. Articles, fixtures, and equipment of a kind to be standard product of one manufacturer.

C. Names and manufacturer's names denote character and quality of equipment desired and are not to be construed as limiting competition.

## PART 3 - EXECUTION

### 3.1 ACCESSIBILITY AND INSTALLATION

A. Install equipment having components requiring access (i.e., drain pans, drains, control operators, valves, motors, drives, and the like) so that they may be serviced, reset, replaced or recalibrated and the like, by service people with normal service tools and equipment. Notify Architect in writing if equipment or components are shown in such a position that above cannot be accomplished.

B. Install equipment complete as directed by manufacturer's installation instructions. Obtain installation instructions from manufacturer prior to rough-in of equipment, examine instructions thoroughly. When requirements of installation instructions conflict with Contract Documents, request clarification from Architect prior to proceeding with installation. This includes proper installation methods and sequencing, in coordination with other trades and disciplines.

C. Earthwork:
1. Refer to Division 31.
2. Perform excavation and backfill for installation of plumbing work.

D. Firestopping:
1. Coordinate with Drawings location of fire rated walls, ceilings, floors and the like. When these assemblies are penetrated, seal around piping, equipment, and the like, with approved firestopping material.
2. Install firestopping material complete as directed by manufacturer's installation instructions. Meet requirements of ASTM E814.

### 3.2 NOISE AND VIBRATION

A. Install vibration isolators, flexible connectors, expansion joints, and measures required to prevent noise and vibration from being transmitted to occupied areas. Select equipment to operate within noise coefficient (NC) design level for particular type of installation in relation to its location.

B. After installation, make proper adjustments to reduce noise and vibration to acceptable levels as defined by Architect.

## 3.3 SEISMIC CONTROL

A. Provide per Section 22 05 48, Vibration and Seismic Controls for Plumbing Piping and Equipment.
   1. General:
      a. Earthquake resistant designs for plumbing equipment, i.e., water heaters, motors, and plumbing piping, to conform to regulations of IBC.
      b. Restraints which are used to prevent disruption of function of piece of equipment because of application of horizontal force to be such that forces are carried to frame of structure in such a way that frame will not be deflected when apparatus is attached to a mounting base and equipment pad, or to structure in normal way, utilizing attachments provided. Secure equipment piping and the like, to withstand a force in direction equal to value defined in IBC.
      c. Retain licensed structural engineer to provide shop drawings of seismic bracing and seismic movement assemblies for piping/equipment/water heaters, and the like. Engineer to design and provide stamped shop drawings for equipment, water heaters, piping seismic bracing, and the like. Submit shop drawings along with equipment submittals.
      d. Retain licensed structural engineer to provide shop drawings of seismic flexible joints for piping and the like crossing building expansion or seismic joints. Engineer to design and provide stamped shop drawings for piping flexible seismic joints. Coordinate actual design deflection or travel with project structural engineer. Submit shop drawings along with seismic bracing details. Coordinate exact design requirements from project structural engineer.
   2. Piping:
      a. Use "Seismic Restraints Manual Guidelines for Plumbing Systems," published by SMACNA.
      b. Sway bracing is not required for pipes that are installed on very short individual hangers (12 inch or less).
      c. As approved by code authority, use a bracing system manufactured by Tolco, Superstrut, Mason, or Pipe Shields Inc. or approved.
   3. Equipment:
      a. Provide a means to prohibit excessive motion of plumbing equipment during earthquake.
      b. Provide plumbing equipment, both hanging and base mounted, with mounting connection points of sufficient strength to resist lateral seismic forces equal to 0.5 of equipment operating weight.

## 3.4 REVIEW BY ENGINEER

A. Notify Architect/Engineer, in writing, at following stages of construction so that Architect/Engineer may, at their option, visit site for review and construction observation:
   1. Underground piping installation prior to backfilling.
   2. Prior to covering walls.
   3. When ceiling installation is started.
   4. When main systems, or portions of, are being tested and ready for inspection by AHJ.

## 3.5 OPERATING DURING CHANGEOVER

A. During remodeling of existing structure, or addition of a structure to existing structure, while existing structure is occupied, present services to remain intact until new construction, facilities or equipment is installed.

B. Prior to changing over to new service, verify that every item is thoroughly prepared. Install new piping, wiring, and the like, to point of connection.

C. Perform actual transfer to new service at off-peak time, as coordinated with Owner. Once changeover is started, pursue it to its completion, to keep interference to a minimum.

## 3.6 MUTILATION

A. Repair mutilation of building around pipes, fixtures, and the like.

## 3.7 DEMOLITION

A. Scope:
   1. It is intent of these documents to provide necessary information and adjustments to plumbing system required to meet code, and accommodate installation of new work.
   2. Coordinate with Owner so that work can be scheduled not to interrupt operations, normal activities, building access, access to different areas.
   3. Existing Conditions: Determine exact location of existing utilities and equipment before commencing work, compensate Owner for damages caused by failure to exactly locate and preserve underground utilities. Replace damaged items with new material to match existing. Promptly notify Owner if utilities are found which are not shown on Drawings.

B. Equipment: Unless otherwise directed, equipment, fixtures, or fittings being removed as part of the demolition process are the Owner's property. Remove other items not scheduled to be reused or relocated from job site as directed by Owner.

C. Unless specifically indicated on the Drawings, remove exposed, unused piping to behind finished surfaces (floor, walls, ceilings, etc.). Cap piping and patch surfaces to match surrounding finish.

D. Unless specifically indicated on the Drawings, remove unused equipment, fixtures, fittings, rough-ins, connectors, etc. Removal is to be to a point behind finished surfaces (floors, walls, ceilings, etc.).

## 3.8 ELECTRICAL INTERLOCKS

A. Where equipment motors are to be electrically interlocked with other equipment for simultaneous operation, utilize plumbing equipment wiring diagrams to coordinate with electrical systems so that proper wiring of equipment involved is affected.

## 3.9 EQUIPMENT SELECTION AND SERVICEABILITY

A. Replace or reposition equipment which is too large or located incorrectly to permit servicing, at no additional cost to Owner.

B. Maintain design intent where equipment other than as shown in Contract Documents is provided. Where equipment requires piping arrangement, control diagrams, or sequencing different from that indicated in Contract Documents, provide electrical motors, wiring, controls, or other required electrical components at no additional cost to Owner.

## 3.10 DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle materials and equipment in a manner to prevent damage and deterioration. Store in original container which identifies manufacturer's name, brand and model number. Do not store indoor equipment outdoors unless provided with a waterproof protective cover.

B. Replacement: In event of damage, immediately make repairs and replacements necessary.

## 3.11 DEMONSTRATION

A. Upon completion of work and adjustment of equipment, test systems to demonstrate to Owner's Representative and Architect that equipment furnished and installed or connected under provisions of these Specifications functions mechanically in manner required.

B. Manufacturer's Field Services: Furnish services of a qualified person for a period of not less than 8 hours, at a time approved by Owner, to instruct maintenance personnel, correct defects or deficiencies, and demonstrate to satisfaction of Owner that entire system is operating in a satisfactory manner and complies with requirements of other trades or Contractors that may be required to complete work. Complete instruction and demonstration prior to final job site observations.

## 3.12 CLEANING

A. Upon completion of installation, thoroughly clean exposed portions of equipment, removing temporary labels and traces of foreign substances. Throughout work, remove construction debris and surplus materials accumulated by this work.

## 3.13 INSTALLATION

A. Install equipment and fixtures in accordance with manufacturer's installation instructions, plumb and level, firmly anchored to vibration isolators. Maintain manufacturer's recommended clearances.

B. Start up equipment, in accordance with manufacturer's start-up instructions, and in presence of manufacturer's representative. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.
   1. Do not place equipment in sustained operation prior to initial balancing of plumbing systems.
   2. Furnish sufficient dry nitrogen for pressure testing under manufacturer's supervision.
   3. Provide and install pump impellers to obtain design capacities. Coordinate exact requirements with balancing firm.

## 3.14 PAINTING

A. Ferrous Metal: After completion of plumbing work, thoroughly clean and paint exposed supports constructed of ferrous metal surfaces in mechanical rooms, i.e., hangers, hanger rods, equipment stands, and the like, with one coat of black asphalt varnish or black enamel suitable for hot surfaces.

B. Machinery:
1. In a mechanical room, on roof or other exposed areas, machinery and equipment not painted with enamel to receive two coats of primer and one coat of rustproof enamel, colors as selected by Architect.
2. See individual equipment Specifications for other painting.
3. Structural Steel: Repair damage to structural steel finishes or finishes of other materials damaged by cutting, welding or patching to match original.

C. Piping: Clean, primer coat and paint exposed piping on roof or at other exterior locations with two coats paint suitable for metallic surfaces and exterior exposures. Color selected by Architect.

## 3.15 CUTTING AND PATCHING

A. Refer to Division 1 for "Cutting and Patching."

## 3.16 ACCEPTANCE

A. System can not be considered for acceptance until work is completed and demonstrated to Architect that installation is in strict compliance with Specifications, Drawings and manufacturer's installation instructions, particularly in reference to following:
1. Testing and balancing reports.
2. Cleaning.
3. System balancing and balancing logs.
4. Operating and Maintenance Manuals.
5. Training of operating personnel.
6. Record Drawings.
7. Guaranty certificates.
8. Start-up and test document.
9. Letter of conformance.

## 3.17 LETTER OF CONFORMANCE

A. Provide letter and copies of extended warranties with a statement in letter that Plumbing items were installed in accordance with manufacturer's recommendations. Include letter of conformance and warranties in operating and maintenance manuals.

B. Warranties to begin at date of substantial completion.

**END OF SECTION**

# SECTION 22 05 12

# PLUMBING PIPE AND FITTINGS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Work Included:
   1. Materials, installation and testing of pipe, tubing and fittings.
   2. Refer to Specification Sections for each system medium (i.e., plumbing, hydronics, gas, and the like), for pipe application.

### 1.2 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer's Qualifications: Firms regularly engaged in manufacture of piping products of types and sizes required.
   2. Welding Qualification: Qualify welding procedures, welders and operators in accordance with ANSI B31.9 for shop and project site welding of piping work.

B. Manufacturer's Inspection: Inspect flanges, fittings and field applied welds in accordance with manufacturer's standard written quality control procedure in accordance with the following techniques:
   1. Visual Method: Comply with MSS SP-55 except as otherwise indicated.
   2. Radiographic (X-Ray) Method: Employ wherever recommended or required for pressurized piping systems.

### 1.3 SUBMITTALS

A. Piping Materials List: Provide a typewritten list which schedules the piping materials to be used for each system as a function of applicable nominal pipe size ranges. Arrange schedule in outline form for each specific piping system, e.g., "Domestic Water System," "Soil, Waste, and Vent Piping System," and the like. Include ASTM, ANSI or other numbers and other data as necessary to demonstrate compliance with requirements.

B. Test Procedure: Submit a typewritten checklist type of testing procedure indicating testing medium (i.e., water, air, nitrogen, and the like), pipe service, pipe and fitting type and classification, test pressure, pass/fail criteria and any other pertinent data.

## PART 2 - PRODUCTS

### 2.1 PIPING - GENERAL

A. Provide pipe, tube and fittings of the type, fitting requirements, grade, class, size and weight indicated or required for each service, as indicated in other Division 22 Specifications. Where type, grade, or class is not indicated, provide proper selection as determined by installer for installation requirements, and comply with governing regulations and industry standards.

### 2.2 STEEL PIPE

A. ASTM A53, Black Welded or Seamless, Grade B: Schedule as specified.

B. ASTM A135, Electric Resistance Welded, Grade B: Black, unless otherwise indicated, schedule as specified.

## 2.3 COPPER TUBE

A. Temper: Annealed (hard drawn).

B. Water Service: ASTM B88, Type as indicated for each service.

C. Drain, Waste, and Vent (DWV): ASTM B306.

## 2.4 CAST IRON PIPE

A. ASTM A74, hub-and-spigot, service weight.

B. ASTM A888/CISPI 301 hubless, including coupling assembly.

## 2.5 FITTINGS FOR STEEL PIPE

A. General: Flanges, fittings, unions and other products, mark in accordance with MSS SP-25.

B. Welding Fittings: Wrought carbon steel fittings, ASTM A234, ANSI B16.9, B16.28. Butt-welding type unless otherwise indicated to be socket welding type.

C. Branch Connections: From mains or headers 2-1/2 inches or larger, welded tees or forged welding outlets.

D. Welding Outlets: "Weldolets" or "Threadolets" equivalent to Bonney Forge. Use forged welding outlets wherever branch line is at least 1 nominal pipe size smaller than local main or header.

E. Threaded Fittings: ANSI B2.1, ASTM A47, 150 PSI rating, except where otherwise specified, prevailing codes or requirements or Specifications dictate use of 300 PSI rating. Fabricate from standard malleable iron with dimensions conforming to ANSI B16.3.
   1. Fitting requirements for galvanized steel piping systems to be the same as for black steel pipe except each to have galvanized coating.
   2. Fittings for waste, vent and drainage piping to be drainage pattern type.

F. Flanges: Carbon steel conforming to ASTM A105, ANSI B16.5, and factory forged in the USA. Flanges which have been machined, remade, painted, or are nondomestic origin are not acceptable. Provide raised or full face ends wherever indicated or required.

G. Unions: ANSI B16.39, ASTM A47, and be fabricated from malleable iron with bronze-to-iron ground joints rated at 150 percent design operating pressure. Threads: ANSI B2.1.

H. Fasteners: Semi-finished carbon steel bolts and hex nuts conforming to ASTM A307. Threads and Dimensions: ANSI B1.1 and B18.2.

I. Threaded Pipe Plugs: ANSI B16.14.

J. Thread Lubricant: RectorSeal No. 5 or Slic-tite Teflon Paste.

## 2.6 FITTINGS FOR COPPER TUBE

A. Wrought copper/bronze solder joint fittings complying with ANSI B16.22.

B. DWV Service:
   1. Cast Copper Solder Joint Drainage Fittings: ANSI B16.23.
   2. Wrought Copper Solder Joint Drainage Fittings: ANSI B16.29.

## 2.7 FITTINGS FOR CAST IRON PIPE

A. Hubless Cast Iron Drainage Pipe Fittings: CISPI 301 as manufactured by ABI, Charlotte or Tyler with stainless steel clamp assemblies.
   1. Manufacturers for heavy-duty or below grade applications meeting FM-1680: Husky SD4000 or Clamp-All high torque couplings.
   2. Manufacturers for standard duty applications: Anaco, Mission, or Tyler.

B. Cast Iron Hub-and-Spigot Drainage Pipe Fittings: Match drainage pipe units, ASTM A74. Fitting joints: Positive seal compression type gaskets, ASTM C564.

## 2.8 MISCELLANEOUS PIPING MATERIALS/PRODUCTS

A. Insulating (Dielectric) Unions: Under no circumstances shall dielectric unions or dielectric pipe nipples be used on heating hot water, domestic and chilled water on piping applications, exterior and interior. To isolate ferrous from nonferrous piping, and prevent galvanic corrosion action, high-grade brass nipples and brass unions at transition points.

B. Welding Materials: Comply with Section 2-C of ASME Boiler Code, as applicable.

C. Tin-Antimony Soldering Materials: ASTM B13.

D. Gaskets for Flanged Joints: ANSI B16.12; full faced for cast iron flanges; raised face for steel flanges, unless otherwise indicated or recommended by manufacturer. Gaskets: Minimum 1/8-inch thick fabricated from nonasbestos bases.

E. Copper-Brazed: Make brazed joints for copper tubing and fittings with code approved brazing filler alloys meeting ASTM and AWS standards and listings. Filler alloys of BCuP2 classification (e.g., "Phos-O" or "Fos-Copper") may not be used to make joints between copper tubing and cast brass or bronze fittings. Filler alloys containing cadmium are not approved for use in potable water piping. Installations conform to accepted published procedures, i.e., UPC Installation Standard 3-75 and CDA Publications. Use of steel wool for cleaning tube and fittings is prohibited.

## 2.9 UNIONS

A. Steel Pipe Union: 150 PSI malleable iron, brass to iron seat, ground joint, black or galvanized to match pipe.

B. Copper Pipe Union: 200 PSI working pressure. Bronze body, solder or grooved ends. Pipes 2 inches and under use ground joint, pipes 2-1/2 inches and larger use flanged face or grooved ends.

C. Insulating Unions: 250 PSI working pressure. Pipe ends and material to match piping. Electric current below 1 percent of galvanic current. Gasket material as recommended by manufacturer. Epco or approved.

## 2.10 ESCUTCHEONS

A. Brass material, chrome plated finish. Size sufficient to cover pipe openings through wall, floor or ceiling. Set screw or spring to secure to pipe. Coordinate opening sizes.

## 2.11 ACCESS PANELS

A. Provide flush mounting access panels as required for service of cleanouts, valves, and the like, and other items requiring maintenance or inspection. Where access panels are located in fire-rated assemblies of building, rate access panels accordingly. Ceiling access panels to be minimum 24x24 (or required and approved size). Wall access panels to be minimum 12x12 (or required and approved size).

B. Manufacturers: Milcor, Karp, Elmdor, In-Ryko, Acudor, or approved. Provide two keys for each set of locks provided.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. General Electrical Equipment Clearances: Do not route piping through electrical rooms, transformer vaults, elevator equipment rooms, and other electrical or electronic equipment spaces and enclosures. Within equipment rooms, provide minimum 3 feet lateral clearance from sides of electric switchgear panels. Do not route piping above any electric power or lighting panel, switchgear, or similar electric device. Coordinate with electrical and coordinate exact pipe routing to provide proper clearance with such items.

B. Installation/Coordination:

1. General: Comply with basic requirements of Section 22 05 29, Hangers and Supports for Plumbing Piping and Equipment. Install pipe, tube and fittings in accordance with recognized industry practices which will achieve permanently leakproof piping systems, capable of performing each indicated service without piping failure. Install each route with a minimum of joints and couplings, but with adequate and accessible unions or flanges for disassembly, maintenance, and replacement of valves and equipment. Reduce sizes by use of reducing fittings. Align piping accurately at connections, within 1/16-inch misalignment tolerance. Comply with ANSI B31.9 Code for Pressure Piping.
2. Installed piping not to interfere with maintenance of equipment, opening of doors or other moving parts nor be directly above or near any portion of electrical equipment.
3. Support piping such that connected equipment and flanges do not bear weight of piping.
4. Adequately support vertical lines at their bases or by a suitable hanger placed in horizontal line near the riser or, preferably, by a base fitting set on a pedestal.
5. Piping not to be suspended or supported by pumps. Apply no force to pumps by connecting pipes. After final pipe adjustments and initial operational verification of the pumps, recheck alignment of pumps and realign as required.
6. Piping systems are to be installed to drain. Provide properly sized drain valves at low points.
7. Ream pipes after cutting to full bore. Remove foreign matter from inside of pipe before installing. Keep installed piping free from dirt and scale and protect open ends from foreign matter. Use temporary plugs or other approved methods for opening and closure.
8. Remake or replace defective, leaking or otherwise unsatisfactory joints or material. Peening, caulking, or doping of piping is not permitted.

9. Install piping to prevent stresses and strains to piping and hangers and supports due to expansion or contraction and building settlement. Provide proper loops, guides, offsets, anchor points, or expansion joints. Verify with anticipated settlement or shrinkage of building. Verify construction phasing of project, type of building construction products and type for coordinating installation of piping systems. Include provisions for servicing and removal of equipment without dismantling piping.
10. Piping Systems Routing Within Unconditioned Spaces, Plenums, Chases, or Cavities:
    a. Unless absolutely unavoidable, route fluid filled and (or) pressurized piping systems on the "warm" side of local building wall, roof, or ceiling thermal insulation batts, boards, or blankets as near to heated space as practical.
    b. Whenever such routing as described above is entirely impractical or impossible, provide heat tracing systems to piping, wherever necessary. Inform Architect before proceeding.
11. Expansion and Flexibility: Install work with due regard for expansion, contraction, and building settlement to prevent damage to the piping, ductwork, equipment and the building and its contents. Provide piping offsets, loops, approved type expansion joints, anchors or other means to control pipe movement, to minimize pipe forces and effects of building settlement.
12. Corrosion Control:
    a. Underground Steel Piping Corrosion Protection: Factory wrap uninsulated underground steel piping systems with protective coating composed of a coal-tar saturated wrapping tape over a 20 mil thick coal-tar epoxy coating, equivalent to "Republic X-Tru-Coat." Wrap joints spirally with a minimum overlap of 1/2 tape width. Extend wrap not less than 3 inches above grade. . Provide tinker test to check for holidays. Provide cathodic protection to meet requirements of NACE Standard RP0169-2002.
    b. Install hot water heating vessels with a stainless steel fitting at tank and a dielectric fitting on both supply and discharge sides of hot water tanks.
13. Pipe Sleeves:
    a. Lay out work in advance of pouring concrete and furnish and set sleeves necessary to complete work.
    b. Floor Sleeves (Except DWV Piping at Slab on Grade): Provide sleeves on pipes passing through concrete or masonry construction. Extend sleeve 1 inch above finished floor. Caulk pipes passing through floor with nonshrinking grout or approved caulking compound. Provide "Link-Seal" Type S sleeve sealing system for slab on grade. Caulk/seal piping passing through fire rated building assembly with UL rated assemblies. Provide fire-rated assemblies per local AHJ requirements.
    c. Wall Sleeves: Provide sleeves on pipes passing through concrete or masonry construction. Provide sleeve flush with finished face of wall. Caulk pipes passing through walls with nonshrinking caulking compound. Caulk/seal piping passing through fire-rated building assemblies with UL approved fire-rated assemblies. Provide fire-rated assemblies per local AHJ requirements.
    d. Beam Sleeves: Coordinate with trades for locations of pipe sleeves in reinforced concrete and steel beams. Penetrations must be indicated on structural shop drawings. See Drawings and Specifications for specific sleeve location limitations. Plumbing Drawings are diagrammatic. Offset piping as required to meet these limitations. Pipe sleeve locations must be indicated on reinforced concrete and steel beam shop drawings. Field cutting of beams not allowed without written approval of structural engineer. No extra costs allowed for failure to coordinate beam penetrations prior to reinforced concrete and steel beam shop drawing submittal.

14. Conform with applicable codes and industry standards.
15. Install uninsulated piping so that unrestrained direct contact with the structure or other system installations is avoided. Where contact with or passage through building or structural features cannot be avoided; firmly anchor piping to, or isolated from, the structure to prevent noise transmission and occurrence of physical damage. Install piping to be insulated with adequate clearance around piping to allow for placement of full thickness insulating material.

C. Pressure Piping Routing:
1. Route piping, except as otherwise indicated, vertically and horizontally (sloped to drain). Avoid diagonal runs wherever possible. Orient horizontal routes parallel with walls and beam lines.
2. Install piping as shown or described by diagrams, details and notations on Drawings or, if not indicated, install piping to provide the shortest route which does not obstruct usable space or block access for servicing the building and its equipment.
3. Support piping adjacent to walls, overhead construction, columns and other structural and permanent enclosure elements of the building. Limit clearance to 1/2 inch wherever furring is indicated for concealment of piping. Allow for insulation thickness, if any. Locate insulated piping to provide minimum 1-inch clearance outside insulation.
4. Wherever possible in finished and occupied spaces, conceal piping from view by locating within column or beam enclosures, hollow wall construction, or above suspended ceilings. Do not encase horizontal routes in solid partitions, except where approved.

D. Preparation:
1. Cast Iron Soil Pipe: Conform with state plumbing code and standards, CISPI recommendations and applicable adopted code amendments.
2. Hubless Cast Iron Joints: Comply with CISPI HSN utilizing calibrated torque wrenches for tightening bands to manufacturer's recommended settings.
3. Unions:
   a. Insulating (Dielectric) Unions: Comply with manufacturer's instructions for installing unions wherever piping of dissimilar metals are adjoined. Install unions in manner which will prevent galvanic action and inhibit corrosion.
   b. Standard Unions: Install where indicated on Drawings and on each side of pieces of equipment to permit easy removal of equipment.
4. Copper Tubing:
   a. Remove burrs from and clean outer surface of tube ends and inner surface of fittings.
   b. Copper-Soldered: Make soldered joints for copper tubing and fittings with code approved solder alloys meeting ASTM and ANSI standards and listings. Solder-paste-flux combination fillers are not approved. Installations to conform to accepted published procedures, i.e., UPC IS 375, IS 21-80 standards and CDA Publications. Use of steel wool for cleaning tube and fittings is prohibited. Apply flux as recommended by manufacturer. Allstate Silver Bearing Solder 430 or other approved solder alloys which do not contain lead or cadmium.
   c. Copper-Brazed: Make brazed joints for copper tubing and fittings with code approved brazing filler alloys meeting ASTM and AWS standards and listings. Filler alloys of BCuP2 classification (e.g., "Phos-0" or "Fos-Copper") may not be used to make joints between copper tubing and cast brass or bronze fittings. Filler alloys containing cadmium are not approved for use in potable water piping. Installations to conform to accepted published procedures, i.e., UPC IS 3-75 standards and CDA Publications. Use of steel wool for cleaning tube and fittings is prohibited. Remove bonnets and nonmetallic seats on valves and cool

body with damp cloth while soldering or brazing. Remove excess flux from completed joints in accordance with manufacturer's instructions and code standards.

d. Copper-Rolled Joints: Pipe ends clean and free from indentations, projections and roll marks in the area from pipe end to rolled area for proper sealing of gasket. Apply a thin uniform coat of nonpetroleum-based lubricant to the gasket, coupling or housing by brush or hand. Place the gasket over one pipe end, the pipe ends aligned and brought together, and the gasket positioned between rolled area and pipe ends. Assemble the coupling housing over the gasket with housing keys engaging both rolled areas. Insert the bolts and nuts started, uniformly tighten until the housing bolt pads are firmly together, metal to metal.

e. Pressurized Service:

1) Unless otherwise indicated, wrought copper/bronze solder joint fittings complying with ANSI B16.22.1995.

2) Copper Tube Unions: Standard products as recommended by manufacturer for use in the service. Rated at 150 percent design operating pressure.

3) Mechanically Formed Tee Connections:

a) Form mechanically extracted collars in a continuous operation consisting of drilling a pilot hole and drawing out the tube surface to form a collar having a height of not less than three times the thickness of the tube wall. Fully adjustable collaring device to ensure roper tolerance and complete uniformity of the joint.

b) Notch the branch to conform with the inner curve of the run tube and dimpled to ensure penetration of the branch tube into the collar is of sufficient depth for brazing and that the branch tube does not obstruct the flow in the main line tube.

c) Braze joints in accordance with the Copper Development Association Copper Tube Handbook using B-cup series filler metal. Note: Soft soldered joints will not be permitted.

E. Cross-Linked Polyethylene Tubing and Fittings:

1. Tubing Installation Under Concrete Slab:
   a. Install tubing in excavated ditch below bottom of Concrete slab. Backfill/encase tubing with sand or pea gravel.
   b. When making 90 degree bends below the slab, use metallic 90 degree bend supports or 90 degree elbows (one size larger than nominal tubing.
2. Tubing Installation Through Wall or Overhead:
   a. Allow tubing slack of 1/8 to 3/16 inch per lineal foot to accommodate thermal expansion. Do not pull tubing tight during installation.
   b. Do not rigidly anchor tubing.
   c. Protect tubing passing through hollow masonry walls or metal studs with sleeves or grommets.
   d. Protect tubing from nail or screw damage with suitable steel plate protectors.
3. Tubing Supports:
   a. Use plastic pipe supports or supports designed for use with plastic tubing.
   b. Place horizontal support every 32 inches for 3/8-, 1/2-, 3/4- and 1-inch tubing.
   c. Provide vertical support at every floor with a mid-story guide placed between floors.
4. Joints and Connections:
   a. Square cut tubing ends, free of burrs or debris, before connection is

made.

b. Make fittings and connections in compliance with manufacturer's recommendations.

c. Make transition joints with manufacturer approved fittings only.

5. Fire Wall, Floor or Ceiling Penetrations:
   a. Firestopping system shall conform to both Flame (F) and Temperature (T) ratings as required by local building codes and as tested by nationally accepted test agencies per ASTM E814 in a configuration that is representative of field conditions.
   b. Use firestop material compatible with tubing as specified herein.
6. Fixture Outlet Rough-In: Provide Type "L" copper tube stubout ells and copper stubout brackets.
7. Inspection and Testing: After completion of any section of the installation, there shall be no visible signs of leakage, cracks, gouges or excess debris.

F. CPVC (Chlorinated Polyvinyl Chloride) Pipe and Fittings:
1. Visually inspect pipe and pipe ends before making a joint. Any damaged pipe ends should be removed. Discard at least 2 inches of pipe beyond any visible cracking.
2. Use an approved tool to cut pipe. Pipe must be cut square to provide maximum glue bonding area.
3. Deburr end of pipe.
4. Use two step glue process, primer and glue. Use an applicator that is approximately one-half the diameter of the pipe being joined. Apply a light, even coating of primer to end of pipe and fitting socket. Apply even coat of cement to end of pipe and fitting socket. Complete the joint by rotating pipe 1/4 to 1/2 turn while inserting the pipe into the fitting, hold in place 5 to 10 seconds. Provide installation per manufacturer's recommendations and code installation standards.
5. Plastic to Metal (Brass) Transitions: Use only brass threaded female adapters to plastic adapters. Do not over torque. Use Teflon tape as a sealant.
6. Hang strap pipe/tubing loosely to allow for thermal expansion. Do not use metal straps with sharp edges. Provide hanger/support spacing per manufacturer's recommendations and code installation standards.
7. Expansion/Contraction: Provide expansion and contraction compensation per manufacturer's recommendations and code installation standards.

## 3.2 FIELD QUALITY CONTROL

A. Inspection:
1. Upon completion of installation of plumbing fixtures and after units are water pressurized, test fixtures to demonstrate capability and compliance with requirements. When possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units and proceed with retesting.
2. Inspect each installed unit for damage to finish. If feasible, restore and match finish to original at site; otherwise, remove fixture and replace with new unit. Feasibility and match to be judged by Architect. Remove cracked or dented units and replace with new units.

## 3.3 ADJUSTING AND CLEANING

A. General: Clean exterior surfaces of installed piping systems of superfluous materials, and prepare for application of painting, insulation, or coatings, if any. Comply with the preparation requirements of Section 22 05 53, Identification for Plumbing Piping and Equipment, and Section 22 07 00, Plumbing Insulation, as applicable. Flush out water filled or drainage piping systems with clean water, and flush other piping systems with dry air or nitrogen after completing required tests. Inspect each segment of each system for

completion of joints, supports, and accessory items.

B. Inspection: Inspect pressurized piping in accordance with the procedures of ANSI B31.9.

## 3.4 PROTECTION

A. Protect piping from damage. Replace damaged items with new.

## 3.5 ESCUTCHEONS

A. Install on exposed pipes passing through walls or floors, and on fixture stops and waste connections to wall.

## 3.6 ACCESS PANELS

A. Install wall and ceiling access panels to provide access to concealed valves, fans, motors, shock arrestors, coils and other mechanical items needing service. Provide access panels at locations required or specified herein. Coordinate locations/sizes of access panels with Architect prior to work.

**END OF SECTION**

# SECTION 22 05 13

# COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Work Included: Materials, installation and testing of motors and starters.

B. Refer to Specification sections for each system medium (i.e., plumbing, circulation pumps, booster pumps, and the like), for motor/starter application.

### 1.2 QUALITY ASSURANCE

A. Motor Manufacturers:
1. General Electric, Westinghouse, U.S. Motors, Wagner, Century/Gould, Louis-Allis, Reliance, Marathon, or approved.
2. Standards: ANSI/IEEE 112 and NEMA MG-1.

B. Starter Manufacturers:
1. Allen Bradley, Square D, General Electric, Siemens, Furnas, Eaton Electrical, or approved.
2. Manufacturer is certified ISO 9002 facility 3, UL listed.

### 1.3 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data, motor efficiency, installation instructions, and dimensioned drawings for each type of motor or starter.

B. Maintenance Data: Submit maintenance data and parts list for each type. Include this data, product data, and certifications in maintenance manual.

## PART 2 - PRODUCTS

### 2.1 ELECTRIC MOTORS

A. Motors: Energy efficient, suitable for nonoverloading operation, and capable of continuous operation at full nameplate rating. Motors 1 HP and larger must meet state energy conservation requirements and recommendations. Motors to be high efficient type similar to Century/Gould E-plus.

B. Take NEMA standards as minimum requirements for motor design and performance. Motors suitable for load, duty, voltage, frequency, hazard and for service and location intended. Motors, unless specified otherwise, to be general purpose open dripproof type, ball bearing equipped, 40C temperature rise; and rated for continuous duty under full load. Motors to have nameplate giving manufacturer's name, shop number, HP, RPM and current characteristics.

C. Motors smaller than 1/2 horsepower, 1 phase; and motors 1/2 horsepower and larger, 3 phase and voltage as indicated on Drawings. Maximum motor speed of 1750 RPM, unless otherwise noted. One phase motors to have internal thermal overload protection with automatic reset.

D. Motors for belt drive to have adjustable bases with set screw to maintain belt tension. Motor horsepowers indicated on the Equipment Schedule on Drawings are the minimum size acceptable.

E. Provide two-speed motors where indicated on schedule or in sequence.

F. Provide inverter rated motors per NEMA MG1-31 where variable frequency drives are applied or soft start starters.

## 2.2 STARTERS

A. Single Phase Motors:
1. Manual across-the-line starting switch having toggle-operated switch pilot running light and built-in thermal overload device with heating element rated not more than 115 percent motor full load current indicated on name plate of motor to be protected. Surface mount starters. Provide NEMA-1 enclosure.
2. Overload relays to be melting alloy type with a replaceable control circuit module. Thermal units to be interchangeable. Starter to be nonoperative if thermal unit is removed.
3. Single phase motors with automatic controls. Provide motor rated relay with coils rated for control voltage.

B. Starters up to size 8 to be suitable for the addition of a minimum of three external auxiliary contacts (normally open or normally closed). Contactor, coils, and relays to perform the control functions of the associated equipment and control sequence.

C. Three phase motors up to and including 15 HP:
1. Provide enclosed type magnetic across-the-line starter with thermal overload and under voltage protection.
2. Operator: "Start-Stop" pushbutton, except where automatic control is indicated on Drawings or specified. Then provide "Hand-Off-Auto" selector switch.
3. Starters for 3 phase motors to have overload protection in each of the three legs, with external manual reset.
4. Unless indicated on Drawings or in Specifications, furnish motor starters with a neon pilot light. Neon lights are required for exhaust fan switches.
5. Equip starters with integral transformer and coil for control circuit. Coordinate coil voltage with control voltage.

D. For 3 phase motors greater than 15 HP:
1. Provide combination starter and fused safety disconnect integral in the same enclosure. Utilize Type 'RK' or 'L' fuses. Provide fuse block with rejection type fuse holders. Size fuses per motor manufacturer's recommendations.
2. Provide a solid-state reduced voltage starter, consisting of power section, one-piece removable printed circuit logic board and field wiring interface terminals. Logic board uses quick disconnect plug-in connectors for current transformers inputs, line-and-load voltage inputs, SCR gate firing output circuits and status panel. Three phase current sensing via current transformers. Class 10 electronic overload protection.
3. Motor starters to include the following protections:
   a. Inverse time running overcurrent protection.
   b. 250 percent to 500 percent current limit adjustment
   c. Minimum and maximum voltage adjustments.
   d. Voltage stability adjustment.
   e. Single-phase protection with built-in short-time delay.
   f. Undervoltage protection with built-in short time delay.

g. MOV surge suppression protection of SCRs rated 10 percent above the rated voltage.
h. Phase sequence protection.

4. Display: Door-mounted status LCD alphanumeric or LED display indicating run, undervoltage, phase loss, phase current unbalance, overcurrent trip, overtemperature, current limit, end of ramp, and incorrect phase rotation.
5. Enclosure: NEMA 12. Operator: "Start-Stop" pushbutton, except where automatic control is indicated on Drawings or specified, then provide "Hand-Off-Auto" selector switch
6. Input/Output Relays: Provide relays as required to provide the control sequence.
7. UL 508 listed.

E. Shaft Grounding:

1. Provide shaft grounding assembly on motors controlled by variable frequency drive. Shaft grounding device to be in the form of brush that resides on the motor shaft. Brush assembly shall be capable of tolerating misalignment and maintaining rotating contact throughout he motor's life.
2. Material: Material used in the grounding assembly shall be stable material commonly used within industry that is not believed to constitute a hazardous material under Office of Safety and Health Act (OSHA regulations.
3. Brushes: Specifically developed carbon compounds of sustained performance with sear life expectancy of 3 years minimum.
4. Seals: In wet or severe environment applications, brush contact area shall be sealed type to keep contaminants from entering the shaft grounding system.
5. For clean room air handling systems, the shaft grounding assembly shall be of the type that contains the wear products within a special enclosure within the shaft grounding system.
6. Shaft grounding assembly installation shall not affect the motor manufacturer warranty. Where the severe environment conditions require application of the shaft grounding types that are screwed into the motor shaft, perform the installation of the shaft grounding system either by the motor manufacturer or by the motor manufacturer authorized facility.
7. Manufacturer: Shaft Grounding Inc. or approved.
8. Bond the brush to the closest ground point using code sized green insulated stranded copper conductor per manufacturer instructions.
9. Test and verify the performance of the assembly to ensure that under no conditions the shaft exceeds 3 volts.

## 2.3 DISCONNECTS

A. Provided by Division 26 unless otherwise specified.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. Install a soft start per the manufacturer's specifications with a minimum clearance of 4 inches on each side of the enclosure.

B. Include a standard wiring diagram for making the appropriate electrical connections.

## 3.2 START UP

A. For soft starters, provide the services of a qualified technician to program, test, and start up soft starts furnished under this Specification.

## 3.3 ELECTRICAL INTERLOCKS

A. Where equipment motors are to be electrically interlocked with other equipment for simultaneous operation, utilize plumbing equipment wiring diagrams to coordinate with the electrical systems so that proper wiring of the equipment involved is affected.

**END OF SECTION**

# SECTION 22 05 23

# GENERAL-DUTY VALVES FOR PLUMBING PIPING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Work Included: Materials, installation and testing of valves, including the following:
1. Gate valves.
2. Globe valves.
3. Drain valves.
4. Ball valves.
5. Balancing valves.
6. Butterfly valves.
7. Swing check valves.

B. Refer to Specification sections for each system medium (i.e., plumbing, hydronics, gas, and the like), for valve application.

### 1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of valves of types and sizes required.

### 1.3 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data, installation instructions, and dimensioned drawings for each type of valve.

B. Maintenance Data: Submit maintenance data and parts list for each type valve. Include this data, product data, and certifications in maintenance manual.

## PART 2 - PRODUCTS

### 2.1 VALVES - GENERAL

A. General:
1. Sizes: Unless otherwise indicated, provide valves of same size as upstream pipe size.
2. Operators: Provide handwheels, fastened to valve stem, for valves other than quarter-turn. Provide lever handle for quarter-turn valves 6 inches and smaller, and four inches and smaller for plug valves. Provide gear operators for quarter-turn valves eight inches and larger and plug valves 5 inches and larger. Provide chain-operated sheaves and chains for overhead valves.
3. End Connections: Mate with pipe, tube and equipment connections. Where more than one type is indicated, selection is installer's option.

B. Service:
1. Domestic Hot and Cold Water Shutoff and Isolation Valves:
a. Pipe Sizes 2-1/2 Inches and Smaller: Ball valve.
b. Pipe Sizes 3 Inches and Larger: Gate valve or butterfly valve.

2. Drain Service; All Pipe Sizes: Drain valves.
3. Strainer Blow-Off: Ball valve.
4. Bypass Around Pressure-Reducing Valves: Globe valves.
5. Check Valves: Swing check valve.

C. Manufacturers: Crane, Fairbanks, Anvil, Jenkins, Kennedy, Walworth, Red/White (commercial grade), Mueller, Legend, Conbraco, Nibco, DeZurik, Hays, Powell, Stockham, Hammond, Watts, Milwaukee, Victaulic, or approved. Note: See individual sections for specialty valves (balancing valves, pressure regulators, relief valves, earthquake valves, gas valves).

## 2.2 GATE VALVES

A. 2 Inches and Smaller: Class 125, bronze, screw-in bonnet, solid wedge. Rising Stem: Nibco 111. Non-Rising Stem: Nibco 113.

B. 2-1/2 Inches and Larger: Flanged ends, Class 125, iron body, bolted bonnet, solid wedge, bronze mounted. OS&Y: Nibco 617-0. Nonrising Stem: Nibco F-619.

## 2.3 GLOBE VALVES

A. 2 Inches and Smaller: Class 125, bronze body, screw-in bonnet, integral seat, renewable disc, straight body, Nibco 211. Angle body, Nibco 311.

B. 2-1/2 Inches and Larger: Class 125, iron body, bolted bonnet, flanged ends, renewable seat and disc, bronze mounted. Straight Body: Nibco F-718-B. Angle Body: Nibco F-818-B.

## 2.4 DRAIN VALVES

A. Class 125, bronze body, screw-in bonnet, rising stem, composition disc, 3/4-inch hose outlet. Threaded: Nibco 73. Solder: Nibco 72.

## 2.5 BALANCING VALVES

A. Bronze with a machined orifice flow restriction, multi-turn globe type valve, internal O-rings, rated working pressure of at least 240 PSIG (175 PSI iron construction, 2-1/2 inches and larger), flow setting indicating pointer and calibrated nameplate, memory stops, and pressure readout port with integral check valve on each side of the orifice. Bell & Gossett, Armstrong, Nibco, Wheatley, Tour & Anderson, or Illinois.

B. Combination check valve/balancing valve not allowed, 1/4 turn plug type allowed on 8 inches and larger pipe only.

## 2.6 BALL VALVES

A. 2-1/2 Inches and Smaller: 150 PSI, bronze body, full port, bronze trim, two-piece construction, TFE seats and seals. Threaded: Nibco T-595-Y. Soldered: Nibco S-595-Y.

B. 3 Inches and Larger: 150 PSI, cast iron body, full port, two-piece body, TFE seats with stainless steel ball. FLA rated for potable water. Flanged Connection: Watts G4000.

C. Standard Port Ball Valve: 2- to 4-inch ductile iron, ASTM A536, micro finish steel chrome plated or stainless steel ball and stem. TFE seats, 600 PSI.

## 2.7 BUTTERFLY VALVES

A. Select lug type valves.

B. 6 Inches and Smaller: 200 PSI, ductile iron body, extended neck, aluminum bronze disc, reinforced resilient EDPM seat, manual lever and lock. Nibco LD2000, or Victaulic 300 for mechanical coupling fittings.

C. 8 Inches and Larger: 200 PSI, ductile iron body, extended neck, aluminum bronze disc, reinforced resilient EDPM seat, gear operator. Nibco DL2000-5, or Victaulic 300 for mechanical coupling fittings.

## 2.8 SWING CHECK VALVES

A. 2 Inches and Smaller: Class 125, bronze body, horizontal swing, regrinding type, Y-pattern, renewable disc. Nibco 413.

B. 2-1/2 Inches and Larger: Class 125, iron body, bolted bonnet, horizontal swing, renewable seat and disc, flanged ends. Nibco F918.

C. Rubber Flapper Check Valve: Horizontal or vertical upward flow installation. Working pressure to 175 PSI. Ductile iron or cast iron body. Steel reinforced Buna-N rubber flapper epoxy coating on wetted parts. Apco Series 100l, Crispin RF Series.

D. Check Valve: Horizontal installation. Working pressure to 300 PSI. Ductile body, ASTM A536, and stainless clapper, EPDM, nitrile or optional viton bumper and bonnet seals. Stainless wetted parts.

## 2.9 PRESSURE AND TEMPERATURE RELIEF VALVES

A. Bronze body, ASME/CSA rated. Sized to meet BTUH and code requirements. Manual lever operator, ANSI listed. Stainless steel or thermal bond coated thermostat tube. Watts, Cash-Acme, or approved.

## 2.10 PRESSURE REGULATING VALVES

A. Water: Bronze body, diaphragm or piston type, spring actuated, with separate or integral strainer, pressure range to suit conditions, code approved for potable water use. Provide shutoff valves, pressure relief valves, unions, drain valve and bypass in accordance with code requirements. Manufacturers: Cash-Acme, Watts, Wilkins, Mueller approved.

B. Water: Automatic control pressure regulating valve, stainless steel seat, stem and spring, diaphragm actuated with brass body, hydraulic control pilots with effluent operating temperature range 32F to 180F, FDA and AWWA approved.

C. Water: Bronze body construction, stainless steel strainer screen, thermal expansion bypass with renewable stainless steel seat and high temperature resisting diaphragm. Watts, Febco, Wilkins, or approved.

## 2.11 ACCESS PANELS

A. Provide flush mounting access panels as required for service of fire dampers, cleanouts, valves, and the like, and other items requiring maintenance or inspection. Where access panels are located in fire-rated assemblies of building, rate access panels accordingly. Ceiling access panels to be minimum 24x24 (or required and approved size). Wall access panels to be minimum 12x12 (or required and approved size).

B. Manufacturers: Milcor, Karp, Elmdor, In-Ryko, Acudor, or approved. Provide two keys for each set of locks provided.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install valves where required for proper operation of piping and equipment, including valves in branch lines where necessary to isolate sections of piping. Locate valves so as to be accessible and so that separate support can be provided when necessary.

B. Install valves with stems pointed up, in vertical position where possible, but in no case with stems pointed downward from horizontal plane unless unavoidable. Install valve drains with hose end adapter for each valve that must be installed with stem below horizontal plane.

C. Insulation: Where insulation is indicated, install extended stem valves, arranged in proper manner to receive insulation.

D. Mechanical Actuators: Install with chain operators where indicated. Extend chains to 5 feet above floor and hook to clips to clear aisle passage.

E. Stem Selection: Outside screw and yoke stems, except provide inside screw, nonrising stem where space prevents full opening of OS&Y valves.

F. Seats: Renewable seats, except where otherwise indicated.

G. Installation of Check Valves:
1. Swing Check Valves: Install in horizontal position with hinge pin horizontally perpendicular to centerline of pipe. Install for proper direction of flow.
2. Rubber Flapper Check Valves: Install in piping line in horizontal or vertical upward flow position for proper direction of flow. To be used exclusively for raw sewage, storm water, or sub-soil water applications. For piping 1-1/2 inches or smaller, provide a swing check valve.

H. Balancing Valves: Install with minimum 4 pipe diameters, straight inlet and outlet pipe or per manufacturer's recommendations.

### 3.2 VALVE ADJUSTING AND CLEANING

A. Inspect valves for leaks. Adjust or replace packing to stop leaks. Replace valve if leak persists.

B. Valve Identification. Tag valves per Section 22 05 53, Identification for Plumbing Piping and Equipment.

### 3.3 ACCESS PANELS

A. Install wall and ceiling access panels to provide access to concealed valves, fans, motors, shock arrestors, fire dampers, terminal units, coils and other mechanical items needing service. Provide access panels at locations required or specified herein. Coordinate locations/sizes of access panels with Architect prior to work.

B. Where access panels are for service of fire, fire/smoke, or smoke dampers, stencil the words "Fire Damper," "Fire/Smoke Damper," or "Smoke Damper" in 1/2-inch-high capital letters on the outside of the panels.

**END OF SECTION**

# SECTION 22 05 29

# HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Work Included: Material and installation of supports, anchors and sleeves including: horizontal piping hangers and supports; vertical piping clamps; hanger rod attachments; building attachments; saddles and shields; miscellaneous materials; equipment supports; anchors; equipment supports; wall and floor sleeves; and escutcheon plates.

### 1.2 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in the manufacture of supports and anchors, of types and sizes required.

B. Regulatory Requirements:
1. Provide pipe hangers and supports whose materials, design and manufacture comply with MSS SP-58, "Pipe Hangers and Supports - Materials, Design and Manufacture," latest edition.
2. Select and apply pipe hangers and supports complying with MSS SP-69, "Pipe Hangers and Supports - Selection and Application," latest edition.
3. A copy of the above-referenced standards on the construction site at all times.

C. Seismic: Provide per Section 22 05 48, Vibration and Seismic Controls for Plumbing Piping and Equipment.

D. Manufacturers: B-Line, Elcen Metal Products Co., F&S Control, Globe, Kindorf, Kinline, Michigan, Superstrut, Unistrut, Power-Strut. Note: See individual Sections for roof equipment support.

### 1.3 SUBMITTALS

A. Submit the following:
1. Manufacturer's technical product data, including installation instructions, for each type of support, anchor and sleeve. Include UL approval drawing from manufacturer for each different pre-engineered firestop assembly.
2. Assembly type shop drawings for each type of sleeve, indicating dimensions, weights, required clearances, and methods of assembly of components.
3. Shop drawings for each individual roof pipe curb assembly, indicating number and location of each pipe or conduit which is to pass through the curb. Indicate pipe insulation requirements.

## PART 2 - PRODUCTS

### 2.1 PIPING HANGERS AND SUPPORTS

A. General:
1. Horizontal Piping Hangers and Supports-Horizontal and Vertical Piping, and Hanger Rod Attachments: Factory fabricated horizontal piping hangers and supports complying with MSS SP-58, to suit piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hangers and

supports to exactly fit pipe size for bare piping, and to exactly fit around piping insulation with saddle or shield for insulated piping. Provide copper-plated hangers and supports for uninsulated copper piping systems.

2. Building Attachments: Factory fabricated attachments complying with MSS SP-58, selected to suit building substructure conditions, in accordance with MSS SP-69 and manufacturer's published product information. Select size of building attachments to suit hanger rods.
3. Saddles and Shields: Factory fabricated saddles or shields under piping hangers and supports for insulated piping. Size saddles and shields for exact fit to mate with pipe insulation. 1/2 round, 18 gauge, minimum 12 inches in length (4-inch pipe and larger to be three times longer than pipe diameter).
4. Roller Hangers: Adjustable roller hanger. Black steel yoke, cast iron roller.
5. Concrete Inserts: Malleable iron body, black finish. Lateral adjustment.
6. Continuous Concrete Insert: Steel construction, minimum 12 gauge. Electrogalvanized finish. Pipe clamps and insert nuts to match.

B. Pipe Hangers Size 2 Inches and Smaller: Adjustable swivel ring hanger, UL listed. Michigan 100 or 101.

C. Pipe Hangers Size 2-1/2 Inches and Larger: Adjustable clevis type, UL listed. Michigan 400.

D. Riser Clamps: Steel, UL listed. Michigan 510 or 511. Copper coated; Michigan 368.

E. Plumbers Tape: Not permitted as pipe hangers or pipe straps.

F. Michigan numbers are indicated for type and quality. Comparable products manufactured by Globe, Elcen, B-Line, Kindorf, Kinline, Unistrut, Anvil, Super Strut, Tolco, PHD, Power-Strut, or approved.

## 2.2 WALL AND FLOOR SLEEVES

A. General:
1. "Link-Seal" Pipe Sleeves: Neoprene gasket links bolted together around an interior sleeve forming a watertight seal. Provide Type S unless otherwise noted. Thunderline Corporation, or approved.
2. Pre-Engineered Firestop Pipe Penetration Systems: UL listed assemblies for maintaining fire rating of piping penetrations through fire-rated assemblies. Comply with ASTM E814.
3. Insulating Caulking: Eagle, Pitcher Super 66 high temperature cement, or approved.
4. Fabricated Accessories:
   a. Steel Pipe Sleeves: Fabricate from Schedule 40 black or galvanized steel pipe. Remove end burrs by grinding.
   b. Sheet Metal Pipe Sleeves: Fabricate from G-90 galvanized sheets closed with lock-seam joints. Provide the following minimum gauges for the sizes indicated:
      1) Sleeve Size 4 Inches in Diameter and Smaller: 18 gauge.
      2) Sleeve Sizes 5 to 6 Inches: 16 gauge.
      3) Sleeve Sizes 7 Inches and Larger: 14 gauge.
   c. Fire-Rated Safing Material:
      1) Rockwool Insulation: Complying with FS-HH-I-558, Form A, Class IV, 6 lbs./cu.ft. density with melting point of 1985F and K value of 0.24 at 75F.
      2) Calcium Silicate Insulation: Noncombustible, complying with FS-HH-I-523, Type II, suitable for 100F to 1200F service with K value of 0.40 at 150F.

## 2.3 ANCHORS

A. General: Anchor supports to existing masonry, block and tile walls per anchoring system manufacturer's recommendations or as modified by project structural engineer.

B. Manufacturers: Anchor-It, Hilti Hit System, Epcon System, or Power Fast System.

# PART 3 - EXECUTION

## 3.1 PREPARATION

A. Examine the Drawings and coordinate for verification of exact locations of fire and smoke rated walls, partitions, floors and other assemblies. Indicate, by shading and labeling on Record Drawings such locations and label as "1-Hour Wall," "2-Hour Fire/Smoke Barrier," and the like. Determine proper locations for piping penetrations. Set sleeves in place in new floors, walls or roofs prior to concrete pour or grouting.

B. Install hangers, supports, anchors and sleeves after required building structural work has been completed in areas where the work is to be installed. Coordinate proper placement of inserts, anchors and other building structural attachments.

## 3.2 INSTALLATION

A. Building Attachments: Install within concrete or on structural steel or wood. Install additional building attachments where support is required for additional concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert secure to forms. Where concrete with compressive strength less than 2500 PSI is indicated, install reinforcing bars through openings at top in inserts.

B. Hangers and Supports:
1. Group parallel runs of horizontal piping to be supported together on trapeze-type hangers. Maximum spacings: MSS SP-69. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not support piping from other piping.
2. Support fire protection piping independently of other piping.
3. Prevent electrolysis in support of copper tubing by use of hangers and supports which are copper plated.
4. Allow controlled movement of piping systems to permit freedom of movement between pipe anchors and to facilitate action of expansion joints, expansion loops, expansion bends and similar units.
5. Piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
6. Insulated Piping: Provide protection saddles where insulation without vapor barrier is indicated. Provide protection shields on insulated piping where insulation with a vapor barrier is indicated.
7. Electrical Equipment Clearances: Do not route piping through electrical rooms, transformer vaults, elevator equipment rooms, and other electrical or electronic equipment spaces and enclosures. Within equipment rooms, provide minimum 3 feet lateral clearance from all sides of electric switchgear panels. Do not route piping above any electric power or lighting panel, switchgear, or similar electric device. Coordinate with Electrical and coordinate exact pipe routing to provide proper clearance with such items.
8. Hanger Spacing:
   a. Cast Iron Soil Pipe: Within 1 foot of each side of joints and at intervals

not to exceed eight feet.
b. Steel Pipe 1 Inch and Smaller: Six feet.
c. Steel Pipe 1-1/4 Inches and Larger: 10 feet.
d. Copper Tubing 1-1/2 Inches and Smaller: Six feet.
e. Copper Tubing 2 Inches and Larger: 10 feet.
f. 90 Degree Offsets: Within two feet, both sides of offsets.

C. Anchors: Install at ends of principal pipe runs where indicated on Drawings. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.

D. Equipment Curbs, and Pipe Curb Assemblies:
1. Provide prefabricated units for roof membrane and insulation penetrations related to plumbing equipment. Coordinate with roofing system. Set supports on the structural deck. Do not set supports on insulation or roofing. Provide level supports by prefabricated pitch built into the curb.
2. Pipe Curb Assemblies: Provide for piping and electrical conduit which penetrates the structural roof deck to service equipment above the roof level (i.e., piping, electrical power and control wiring).
3. Piping above roof to be supported with freestanding roof pipe supports unless detailed otherwise.

E. Escutcheon Plates: Install around horizontal and vertical piping at visible penetrations through walls, partitions, floors, or ceilings, including penetrations through closets, through below ceiling corridor walls, and through equipment room walls and floors.

F. "Link-Seal" Pipe Sleeves: Install at exterior wall piping penetrations. For penetrations below grade provide Schedule 40 steel sleeve with 1-inch, continuously welded, "weep ring" centered on length of sleeve.

G. Fabricated Pipe Sleeves:
1. Provide either steel or sheet metal pipe sleeves accurately centered around pipe routes. Size such that piping and insulation, if any, will have free movement within the sleeve, including allowance for thermal expansion. Sleeves not to be more than 1 pipe size larger than piping or piping plus insulation size.
2. Length: Equal to thickness of construction penetrated, except extend floor sleeves 1/4 inch above floor finish and, where floor surface drains to a floor drain, extend floor sleeve 3/4 inch above floor finish.
3. Provide temporary support of sleeves during placement in concrete and other work around sleeves. Provide temporary end closures to prevent concrete and other materials from entering pipe sleeves.
4. Seal each end airtight with a resilient nonhardening sealer.

H. Installation of metallic or plastic piping penetrations through non fire-rated walls and partitions and through smoke-rated walls and partitions:
1. Install fabricated pipe sleeve.
2. After installation of sleeve and piping, tightly pack entire annular void between piping or piping insulation and sleeve I.D. with specified material.

I. Piping penetrations through fire-rated (1 to 3 hour) assemblies: Select and install pre-engineered pipe penetration system in accordance with the UL listing and manufacturer's recommendation.

## 3.3 ADJUSTING AND PAINTING

A. Adjust hangers so as to distribute loads equally on attachments. Provide grout under supports to bring piping and equipment to proper level and elevations.

B. Prime paint ferrous nongalvanized hangers, accessories, and supplementary steel which are not factory painted.

## 3.4 FIRESTOPPING PENETRATIONS IN FIRE-RATED WALL/FLOOR ASSEMBLIES

A. Provide proper sizing when providing sleeves or core-drilled holes to accommodate the penetration. Firestop voids between sleeve or core-drilled hole and pipe passing through to meet the requirements of ASTM E84.

B. Manufacturers: Hilti, Proset, or approved.

**END OF SECTION**

# SECTION 22 05 48

# VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Work Included: Materials and installation of seismic restraint devices and related items. Provide complete vibration isolation systems in proper working order.

### 1.2 SEISMIC CONTROL AND RESTRAINT

A. Plumbing Equipment:
1. Brace or anchor plumbing equipment to resist a horizontal force acting in any direction using CBC Seismic Restraint requirements.
2. Vibration Isolated Equipment: Provide factory fabricated seismic restrained vibration isolating components. Earthquake resistant designs for plumbing equipment, i.e., water heaters, motors, and plumbing piping, to conform to the regulations of the CBC Seismic Restraint requirements. Where standard factory fabricated components are not available, provide properly designed custom components which meet the requirements herein.
3. Provide any restraints noted on Drawings for Division 22 work.

B. Anchorage:
1. Where anchorage details are not shown on Drawings, the field installation subject to approval of the project structural engineer.
2. In other cases, retain a professional structural engineer licensed in the state in which the work will be done to provide shop drawings of seismic bracing for ductwork/equipment/water heaters. Professional engineer to design and provide wet stamped (sealed) shop drawings for equipment, water heaters, and piping seismic bracing. Submit shop drawings and calculations along with equipment submittals.
3. The restraints which are used to prevent disruption of the function of the piece of equipment because of the application of the horizontal force to be such that the forces are carried to the frame of the structure in such a way that the frame will not be deflected when the apparatus is attached to a mounting base and equipment pad, or to the structure in the normal way, utilizing the attachments provided. Secure equipment to withstand a force in any direction.

C. Specify the seismic bracing and anchorage of piping in Section 22 05 29, Hangers and Supports for Plumbing Piping and Equipment.

D. Provide earthquake bumpers to prevent excessive motion during starting and stopping of equipment and for earthquake bracing. Install bumpers after equipment is in operation to allow proper placement and alignment and ensure that bumpers are not engaged during normal system operation.

### 1.3 RUSTPROOFING

A. General: Design vibration isolation hardware or treat for corrosion resistance.

B. Isolators exposed to weather to have steel parts zinc electroplated, PVC coated, plus coating of neoprene or bitumastic paint. Etch aluminum components for outdoor installation and paint with industrial grade enamel.

C. Nuts, bolts and washers zinc electroplated.

D. Structural steel bases thoroughly cleaned of welding slag, primed with zinc chromate and finished with two coats of industrial enamel.

## 1.4 ELECTRICAL CONNECTIONS

A. Make electrical connections to plumbing equipment motors through a flexible conduit designed to reduce motor vibration transfer into the rigid conduit which is directly attached to the building structure.

B. Flexible Conduit: Sufficiently long to provide a 360 degree loop in the flex between the motor and the rigid conduit. Route conduit through side of equipment roof curb and attaching flexible conduit. Caulk around curb penetration water tight.

C. Provide a soft neoprene bushing at the connection point between the flex and the rigid conduit to break the metal-to-metal contact.

D. Ground wires from vibrating equipment to be flexible with sufficient slack to prevent vibration transfer. Ground wires must not directly contact structural membranes (floors, walls or ceilings) of the building.

## 1.5 QUALITY ASSURANCE

A. Coordinate the size, location, and special requirements of vibration isolation equipment and systems with building systems. Coordinate plan dimensions of final selections and plumbing equipment with size of housekeeping pads.

B. Supply and install any incidental materials needed to meet the requirements stated herein.

## 1.6 SUBMITTALS

A. Provide a complete description of products to be supplied including product data, dimensions and specifications. Provide installation instructions for each product.

B. Provide a complete tabulation showing for each piece of vibration isolator supporting equipment the following:
1. The equipment identification mark.
2. The isolator type with rated load.
3. The actual load per isolator.

C. Provide fabrication/shop drawings of steel rails, inertia bases, steel base frames, reinforcing, vibration isolator mounting attachment method, unitary straps and location of equipment attachment bolts.

D. Provide structural calculations for isolator seismic restraint for plumbing equipment including, but not limited to boilers, roof curbs, fuel storage tanks, pumps, water heaters, storage tanks, sealed by a professional structural engineer, registered in the state of California.

# PART 2 - PRODUCTS

## 2.1 SEISMIC RESTRAINTS FOR PIPING

A. Use the document "*Seismic Restraints Manual Guidelines for Mechanical Systems.*"

Secure piping, ductwork, and the like to withstand a force in any direction.

B. Sway bracing is not required for pipes that are installed on very short hangers (12 inches or less).

C. Secure HVAC and plumbing piping bracing at every fourth hanger transversely and every eighth hanger longitudinally.

D. As approved by code authority, use a bracing system manufactured by Superstrut, Mason, or Pipe Shields Inc., or approved.

## 2.2 EQUIPMENT

A. Provide a means to prohibit excessive motion of plumbing equipment during an earthquake.

B. Provide plumbing equipment, both hanging and base mounted, with mounting connection points of sufficient strength to resist lateral seismic forces equal to 0.5 of equipment operating weight.

## 2.3 FLEXIBLE PIPE CONNECTIONS (FPC)

A. Straight, double sphere shape fabricated of multiple plies of nylon cord, fabric and neoprene, vulcanized so as to become inseparable and homogenous. Able to accept compressive, elongative, transverse and angular movements.

B. Select and fit to suit the system temperature, pressure and fluid type. Do not use rods or cables to control extension of the connector.

C. Pipe Sizes 2 Inches or Smaller: Threaded female union couplings on each end. Larger sizes: Metallic flange couplings.

D. FPC: Mason MFTNC.

E. Manufacturers: Supply vibration isolation mounts by a single manufacturer. Acceptable suppliers are as follows: Amber/Booth Co. - A.B., Korfund Dynamics - K.D., Mason Industries, Inc. - M.I., Peabody Noise Control Inc. - P.N.C., Vibration Mountings & Controls, Inc. - V.M.&C., Metraflex, Vibrex.

F. Connections to match piping system.

G. Three Flexible Grooved Couplings Option: Where grooved systems are used, three Victaulic Style 77 couplings may be used in lieu of double sphere or metallic type flexible pipe connectors. See Victaulic publication "Vibration Attenuation Characteristics of Victaulic Couplings 26.04" for additional details.

## 2.4 GROMMETS

A. Combine a neoprene washer and sleeve.

B. Isogrommets manufactured by MBPS, Inc.

C. Series W by Barry Controls, or approved.

D. Neoprene Durometer: Between 40 and 50. Grommets: Specially formed to prevent fastening bolts from directly contacting the isolator base plate.

## 2.5 RESILIENT NONHARDENING SEALANT

A. Sealants for Acoustical Purposes: DAP acoustical sealant.

B. Manufacturers: Pecra, Tremco, USG, or approved.

## 2.6 ACCESS PANELS

A. Provide flush mounting access panels as required for service of fire dampers, cleanouts, valves, and the like, and other items requiring maintenance or inspection. Where access panels are located in fire-rated assemblies of building, rate access panels accordingly. Ceiling access panels to be minimum 24x24 (or required and approved size). Wall access panels to be minimum 12x12 (or required and approved size).

B. Manufacturers: Milcor, Karp, Elmdor, In-Ryko, Acudor, or approved. Provide two keys for each set of locks provided.

# PART 3 - EXECUTION

## 3.1 APPLICATION

A. General:

1. Set floor-mounted major equipment on 4-inch-high housekeeping type concrete pads, as detailed. Extend pad 6 inches beyond footprint of equipment in each direction.
2. Install flexible pipe connections (FPC) at pipe connections to vibration isolated equipment. Included, but not be limited to, pumps, emergency generators, commercial washer/dryers, and the like.
3. Isolate miscellaneous pieces of plumbing equipment, i.e., storage tanks and expansion tanks from the building structure by NP or HN isolators.
4. Provide mounts for equipment installed outdoors for wind loads of 30 lbs. psf applied to any exposed surface of the isolated equipment.
5. Under no circumstances destroy isolation efficiency by bolting the isolators to the roof or floor or equipment. If bolting is necessary, provide rubber grommets and washers to isolate the bolt from the base plate.
6. Building Penetrations: Isolate water piping penetrating wall, ceilings, floors or shafts from the structure by piping isolator or by 3/8-inch thick foamed rubber insulation. Install units flush with finished structure face, using one for each side as required. Cut units to length if longer than structure thickness. Caulk around pipe or duct at equipment room wall.
7. Hot and Cold Plumbing Pipes: Isolate hot and cold water piping in plumbing chases and walls behind plumbing fixtures, which are adjacent to occupied areas, from the structure by a piping isolator, Cush-A-Strip S-716, or a 6-inch section of 3/8-inch thick foamed plastic between the hanger and pipe. Contractor's Option: Acousto-Plumb System using plastic bushings.
8. Pipe Hangers in Mechanical Rooms: Support water, gas piping , and the like, connected to rotating equipment within the mechanical rooms on spring and neoprene hangers. The first three hangers from a piece of vibrating equipment to have a minimum of 1/2 the static deflection of that of the equipment isolators. Other isolators should have a minimum of 1/4 the static deflection of that of the equipment.

B. Drain Service Piping Connected to Vibration Isolated Equipment: Do not contact the building structure or other nonisolated system unless it is resiliently mounted as described above.

## 3.2 VIBRATION ISOLATION EQUIPMENT INSTALLATION

A. General: Install vibration isolation equipment in accordance with the manufacturer's written instructions.

B. Isolation Mounts:
1. Squarely align vibration isolators above or below mounting points of the supported equipment.
2. If a housekeeping pad is provided, install isolators such that they bear on the housekeeping pad and the isolator base plate rests entirely on the pad.
3. Connect hanger rods for vibration isolated support to structure. Provide intermediate members as necessary.
4. Position vibration isolation hanger elements as high as possible in the hanger rod assembly but not in contact with the building structure. Install hangers so that the hanger housing may rotate a full 360 degrees about the rod axis without contacting any object.
5. Where parallel running pipes are hung together on a trapeze which is isolated from the building, provide isolator deflections for the largest determined by provisions for pipe isolation. Do not mix isolated and nonisolated pipes in the same trapeze.
6. Install resiliently isolated pipes such that they do not contact any rigid building structure or equipment.
7. Install FSNTL isolators such that the installed and operating heights of vibration isolated equipment is identical. Install limit stops so that they are out of contact during normal operation.
8. Adjust leveling bolts and hanger rod bolts so the isolated equipment is level and in proper alignment with connecting ducts or pipes.

C. Inertia Bases: Unless otherwise indicated, provide a minimum operating clearance of 1-1/2 inches between structural steel frames and the concrete housekeeping pad or floor beneath the equipment. Position isolator mounting brackets so that the required clearance is maintained. Check the clearance space to ensure that no construction debris has been left to short circuit or restrict the proper operation of the vibration isolation system.

D. Flexible Pipe Connections: Install flexible pipe connections to minimize initial misalignment.

E. Foam Rubber: Provide foam rubber sheets between fan bases and roof mounted equipment curbs and between rooftop mounted HVAC equipment and their curbs.

F. Anchorage: Adequately anchor or brace plumbing equipment and piping to resist displacement due to seismic action, include snubbers on equipment mounted on spring isolators, chiller, pump, cooling tower, and the like.

## 3.3 ADJUSTING AND CLEANING

A. Clean each vibration isolator. Verify that each is working freely, and that there is no debris in the immediate vicinity of the unit that could short circuit unit isolation.

## 3.4 ACCESS PANELS

A. Install wall and ceiling access panels to provide access to concealed valves, fans, motors, shock arrestors, fire dampers, terminal units, coils and other mechanical items needing service. Provide access panels at locations required or specified herein. Coordinate locations/sizes of access panels with Architect prior to work.

**END OF SECTION**

# SECTION 22 05 53

# IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Work Included: Materials and installation of plumbing systems identification.

### 1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of identification devices of types and sizes required.

B. Codes and Standards: Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices, unless otherwise indicated.

### 1.3 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data and installation instructions for each identification material and device required.

B. Schedules: Submit valve schedule for each piping system, typewritten and reproduced on 8-1/2- by 11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), and variations for identification (if any). Mark valves which are intended for emergency shutoff and similar special uses by special "flags" in margin of schedule. In addition to mounted copies, furnish extra copies for maintenance manuals.

## PART 2 - PRODUCTS

### 2.1 PLUMBING IDENTIFICATION MATERIALS

A. General: Manufacturer's standard products of categories and types required for each application as referenced in other Division 22 sections. Where more than a single type is specified for application, provide single selection for each product category.

B. Manufacturers: Allen Systems, Inc., W. H. Brady Co., Signmark Division, Industrial Safety Supply Co., Inc., Seton Name Plate Corporation, or approved.

### 2.2 PLASTIC PIPE MARKERS

A. Provide one of the following:
   1. Snap-on Type: Manufacturer's standard preprinted, semi-rigid snap-on, color-coded pipe markers.
   2. Pressure-Sensitive Type: Manufacturer's standard preprinted, permanent adhesive, color-coded, pressure sensitive, vinyl pipe markers.

B. Small Pipes: For external diameters less than 6 inches (including insulation, if any), provide full-band pipe markers, extending 360 degrees around pipe at each location, fastened by one of the following methods:
   1. Snap-on application of pretensioned semi-rigid plastic pipe marker.
   2. Adhesive lap joint in pipe marker overlap.
   3. Laminated or bonded application of pipe marker to pipe (or insulation).

4. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 3/4 inch wide; full circle at both ends of pipe marker, tape lapped 1-1/2 inches.

C. Large Pipes: For external diameters of six inches and larger (including insulation, if any), provide either full-band or strip-type pipe markers, but not narrower than three times letter height (and of required length), fastened by one of the following methods:
1. Laminated or bonded application of pipe marker to pipe (or insulation).
2. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 1-1/2 inches wide; full circle at both ends of pipe marker, tape lapped 3 inches.
3. Strapped-to-pipe (or insulation) application of semi-rigid type, with manufacturer's standard stainless steel bands.

D. Lettering: Comply with piping system nomenclature as specified, scheduled or shown, and abbreviate only as necessary for each application length.

E. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as separate unit of plastic.

## 2.3 VALVE TAGS

A. Brass Valve Tags: Polished brass valve tags with stamp-engraved piping system abbreviation in 1/4-inch high letters and sequenced valve numbers 1/2 inch high, and with hole for fastener. 1-1/2-inch diameter tags, except as otherwise indicated. Valve designations to be coordinated with *existing* valve identifications to ensure no repetitive designations are utilized.

B. Valve Tag Fasteners: Solid brass chain (wire link or beaded type), or solid brass S-hooks.

C. Access Panel Markers: Manufacturer's standard 1/16-inch thick engraved plastic laminate access panel markers, with abbreviations and numbers corresponding to concealed valve. Include center hole to allow attachment.

## 2.4 PLASTIC EQUIPMENT MARKERS

A. General: Manufacturer's standard laminated plastic, color-coded equipment markers. Conform to the following color code:
1. Green: Cooling equipment and components.
2. Yellow: Heating equipment and components.

B. Nomenclature: Match terminology used on drawing schedules as closely as possible.

C. Size: Provide approximate 2-1/2- by 4-inch markers for control devices, dampers, and valves; and 4-1/2- by 6-inch markers for equipment.

## 2.5 LETTERING AND GRAPHICS

A. General: Coordinate names, abbreviations and other designations used in plumbing identification work with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of plumbing systems and equipment.

B. Multiple Systems: Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (as examples: Boiler No. 3, Circulation Pump No. 42, Cold water riser No. 12, and the like).

## PART 3 - EXECUTION

### 3.1 GENERAL INSTALLATION REQUIREMENTS

A. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in finished plumbing spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

### 3.2 PIPING SYSTEM IDENTIFICATION

A. Install pipe markers on each system and include arrows to show normal direction of flow.

B. Locate pipe markers and color bands wherever piping is exposed to view in occupied spaces, machine rooms, accessible maintenance spaces (shafts, tunnels and plenums), and exterior nonconcealed locations, in locations as follows:

1. Near each valve and control device.
2. Near each branch, excluding short take-offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.
3. Near locations where pipes pass through walls or floors/ceilings, or enter nonaccessible enclosures.
4. At access doors, manholes and similar access points which permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced intermediately at maximum spacing of 20 feet along each piping run, except reduce spacing to 10 feet in congested areas of piping and equipment, i.e., mechanical rooms.

### 3.3 VALVE IDENTIFICATION

A. General: Provide valve tag on every valve, cock and control device in each piping system. Exclude check valves, valves within factory fabricated equipment units, plumbing fixture faucets, convenience and lawn-watering hose bibbs, shutoff valves at plumbing fixtures, and similar rough-in connections of end use fixtures. List each tagged valve in valve schedule for each piping system.

B. Install mounted valve schedule in each mechanical room.

### 3.4 PLUMBING EQUIPMENT IDENTIFICATION

A. General: Install engraved plastic laminate sign or plastic equipment marker on or near each item of plumbing equipment and each operational device, as specified herein if not otherwise specified for each item or device. Provide signs for the following general categories of equipment and operational devices: Pumps, compressors, and similar motor driven units, water heaters, tanks and pressure vessels, filters, water treatment systems and similar equipment.

## 3.5 ADJUSTING AND CLEANING

A. Adjusting: Relocate any plumbing identification device which has become visually blocked.

B. Cleaning: Clean face of identification devices, and glass frames of valve charts.

**END OF SECTION**

# SECTION 22 07 00

# PLUMBING SYSTEMS INSULATION

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Piping and Equipment Insulation: Materials and installation of insulation, jackets and accessories for the following applications:
1. Hot and cold domestic water piping systems.
2. Storm water piping systems.
3. Condensate piping systems.
4. Make-up water piping systems.
5. Hot and cold surfaces of plumbing equipment.
6. Underside of roof drain and overflow drain bodies.
7. ADA accessible lavatory/sink P-trap and supplies/stops.
8. Storage tanks.
9. Heat tracing.

### 1.2 QUALITY ASSURANCE

A. Qualification of Workers: Use proficient journeyman insulators and supervisors in the execution of this portion of the work to ensure proper and adequate installation of insulation throughout. A firm with at least 5 years successful installation experience on projects with installations similar to that required for this project.

B. Compliance with Specifications:
1. Whenever required during progress of the work, furnish proof acceptable to the Owner that items installed are equal to or exceed requirements specified for this work.
2. In the event such proof is not available, or is not acceptable to the Owner, the Owner may require the Contractor to remove the item or items and replace with material meeting the specified requirements and to repair damage caused in the removal and replacement, at no additional cost to the Owner.
3. Install per manufacturer's written instructions.
4. As a minimum, comply with appropriate state energy code or other applicable codes.

### 1.3 SUBMITTALS

A. Product Data: Submit manufacturer's technical data and installation instructions for each type of insulation, jacket, glue, paint, fitting cover, and accessory. Submit schedule showing manufacturer's product number, thickness, and furnished accessories for each piping, equipment and duct system requiring insulation.

### 1.4 PRODUCT HANDLING

A. Protection: Use means necessary to protect insulation materials before, during and after installation.

B. Replacements: In the event of damage, immediately make repairs and replacements necessary.

## 1.5 FIRE HAZARD CLASSIFICATION

A. Maximum fire hazard classification of the composite insulation construction as installed to be not more than a flame spread of 25, fuel contributed of 50 and smoke developed of 50 as tested by ASTM E84 (NFPA 255) method.

B. Test pipe insulation in accordance with the requirements of UL "Pipe and Equipment Coverings R5583 400 8.15."

C. Test duct insulation in accordance with ASTM E84 and bear the UL label.

# PART 2 - PRODUCTS

## 2.1 MANUFACTURERS

A. Piping: Armacell LLC Armaflex, Certainteed, Imcoa, Johns Manville, Knauf, Nomaco, Owens-Corning, PPG, or approved.

## 2.2 TYPE 1, FIBERGLASS PIPE INSULATION

A. Glass Fiber: ASTM C547; rigid molded, noncombustible.
1. Thermal Conductivity Value: 0.27 at 75F.
2. Maximum Service Temperature: 850F.
3. Vapor Retarder Jacket: White Kraft paper reinforced with glass fiber and bonded to aluminum foil, secure with self sealing longitudinal laps and butt strips or AP Jacket with outward clinch expanding staples or vapor barrier mastic as needed.

## 2.3 TYPE 2, FLEXIBLE ELASTOMERIC INSULATION

A. Elastomeric Foam: ASTM C534; flexible, cellular elastomeric, molded or sheet.
1. Thermal Conductivity Value: 0.27 at 75F.
2. Maximum Service Temperature of 220F.
3. Maximum Flame Spread: 25.
4. Maximum Smoke Developed: 50 (3/4 inch thick and below).
5. Connection: Waterproof vapor retarder adhesive as needed.
6. UV Protection: UV outdoor protective coating as needed.

B. Glue Used in Cementing Rubber Insulation: Contact adhesive specifically manufactured for cementing flexible elastomeric foam. Armacell LLC Armaflex 520 adhesive, or Halstead.

C. Paint Used to Cover Rubber Insulation: Nonhardening high elasticity type, specifically manufactured as a protective covering of flexible elastomeric foam insulation for the prevention of degradation due to exposure to sunlight and weather. Armacell LLC Armaflex, or Halstead.

## 2.4 TYPE 6, FIBERGLASS EQUIPMENT INSULATION

A. Flexible Fiberglass Blanket: ASTM C612; flexible.
1. Thermal Conductivity Value: 0.24 at 75F.
2. Maximum Service Temperature: 450F.

## 2.5 TYPE 7, ADA ACCESSIBLE LAVATORY/SINK INSULATION KIT

A. P-traps, hot water and cold water insulating guards. Molded closed cell vinyl with nylon fasteners, paintable. Thermal conductivity; K = 1.17 (BTU/in)/ (hr/sq.ft./deg. F) at 75F mean temperature. Provide accessories as required for complete installation. Color white. Truebro Inc. Model 102. McGuire, ProWrap, Brocar Trap Wrap, or approved.

## 2.6 JACKETING

A. PVC Plastic Fitting Covers: Schuller Zeston 2000. One-piece molded type fitting covers and jacketing material, gloss white. Connections: Tacks; pressure sensitive color matching vinyl tape.

B. Canvas Jacket: UL listed fabric, 6 oz/sq.yd., plain weave cotton treated with dilute fire retardant lagging adhesive.

C. Aluminum Jacket: 0.016-inch-thick sheet, (smooth/embossed) finish, with longitudinal slip joints and 2-inch laps, die-shaped fitting covers with factory attached protective liner.

D. Stainless Steel Jacket: Type 304 stainless steel, 0.010 inch, (smooth/corrugated) finish.

## 2.7 ACCESSORIES

A. Equipment Insulation Jacketing: Presized glass cloth, not less than 7.8 ounces/sq.yd., except as otherwise indicated. Coat with gypsum based cement.

B. Equipment Insulation Compounds: Provide adhesives, cement, sealers, mastics and protective finishes as recommended by insulation manufacturer for applications indicated.

C. General: Provide staples, bands, wire, wire netting, tape corner angles, anchors, stud pins and metal covers as recommended by insulation manufacturer for applications indicated. Accessories, i.e., adhesives, mastics, cements and tape to have the same flame and smoke component ratings as the insulation materials with which they are used. Shipping cartons to bear a label indicating that flame and smoke ratings do not exceed those listed above. Provide permanent treatment of jackets or facings to impart flame and smoke safety. Provide nonwater soluble treatments.

## 2.8 PIPE FITTING INSULATION COVERS

A. PVC preformed molded insulation covers. Zeston, or approved.

# PART 3 - EXECUTION

## 3.1 VERIFICATION OF CONDITIONS

A. Do not apply insulation until pressure testing of the ducts has been completed. Do not apply insulation until the duct has been inspected.

B. Examine areas and conditions under which duct insulation will be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

## 3.2 PREPARATION

A. Clean and dry surfaces to be insulated.

## 3.3 INSTALLATION

A. Insulation: Continuous through walls, floors, partitions except where noted otherwise.

B. Piping and Equipment:
   1. Install insulation over clean, dry surfaces with adjoining sections firmly butted together and covering surfaces. Fill voids and holes. Seal raw edges. Install insulation in a manner such that the insulation may be split, removed, and reinstalled with vapor barrier tape on strainer caps and unions. Do not install insulation until the piping has been leak tested and has passed such tests. Do not insulate chiller manholes, equipment manufacturer's nameplates, handholes, and ASME stamps. Provide beveled edge at such insulation interruptions. Repair voids or tears.
   2. Cover insulation on pipes above ground, outside of buildings, with aluminum jacketing. Position seam on bottom of pipe.

## 3.4 PROTECTION AND REPLACEMENT

A. Protect installed insulation during construction. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.

## 3.5 FIBERGLASS INSULATION

A. Lap seal insulation with waterproof adhesive. Do not use staples or other methods of attachment which would penetrate the vapor barrier. Apply fitting covers with seated tacks and vapor barrier tape.

B. Apply insulation to pipe and seal with self-sealing lap. Use self-sealing butt strips to seal butt joints. Insulate fittings, valves and unions with single or multiple layers of insulation and cover to match pipe or use preformed PVC molded insulation covers.

## 3.6 LABELING AND MARKING

A. Provide labels, arrows and color coding on piping per Section 22 01 00, Plumbing Materials and Methods. Section 22 05 53, Identification for Plumbing Piping and Equipment. Attach labels and arrows to the jacketing.

## 3.7 PIPING SURFACES TO BE INSULATED

| Item to be Insulated: | System Insulation Type: | Pipe Size: | Insulation Thickness: |
|---|---|---|---|
| Domestic hot water and hot water circulation piping above grade. | 1 | Runouts up to 2"<br>Mains =<2"<br>Mains >2" | 1"<br>1"<br>1-1/2" |
| Domestic hot and cold water, piping and hot water circulation piping below grade. | 2 | All | 1-1/2" |
| Domestic water piping exposed to weather and drainage pipe with heat tracing. | 1, 2 | All | 1-1/2" |
| Domestic cold water except minor branch piping within walls serving fixtures. | 1 | =<2"<br>>2" | 1/2"<br>1" |
| Rain conductors, above grade horizontal and vertical piping. | 1 | All | 1/2" |
| Roof drain/overflow underbodies. | 6 | N/A | 1" |
| ADA accessible lavatory/sink. | 7 | All | as listed |
| Storage tanks. | 6 | All | 2" |
| Condensate drain piping. | 1 | All | 1/2" |
| Aboveground steam and steam condensate piping. | 1 | Runouts up to 2"<br>All others | 1"<br>1-1/2" |
| Aboveground refrigerated water systems. | 1 | All | 1" |

Note: Insulation thickness shown is a minimum. If state codes or AHJ require additional thickness, provide insulation thickness per code and AHJ requirements.

## 3.8 ROOF DRAIN/OVERFLOW DRAIN UNDERBODIES AND PIPING

A. Above grade, cover all roof drain and overflow drain piping with sectional pipe covering. Cover underside of drain body with insulation; attached with adhesive and supported externally with 26-gauge galvanized flat strapping anchored to structure.

## 3.9 ADA ACCESSIBLE LAVATORIES/SINKS

A. Install lavatory/sink insulation kit.

## 3.10 STORAGE TANKS

A. Cover with hydrous calcium silicate, 2-inches thick. Finish with canvas jacket and adhesive. Overlap joints minimum of 4 inches. Apply two coats latex paint; color selected by Architect.

## 3.11 INSULATION SHIELDS

A. Provide full size diameter hangers and shields (18 gauge minimum) for cold piping. Hot water piping hangers may penetrate insulation to contact pipe directly. Provide 18-inch long, noncompressible insulation section at insulation shields for lines 2 inches and larger (steam and cold piping).

## 3.12 FOAMED PLASTIC EQUIPMENT INSULATION

A. Apply insulation and accessories to roof drain/overflow underbodies per manufacturer's recommendations.

**END OF SECTION**

# SECTION 22 11 13

# GENERAL PLUMBING PIPING SYSTEMS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Work includes but is not limited to:
1. Aboveground soil, waste and vent piping within buildings, including soil stacks, vent stacks, horizontal branches, traps, and connections to fixtures and drains.
2. Underground building drain piping including mains, branches, traps, connections to fixtures and drains, and connections to stacks, terminating at connection to sanitary sewers 5 feet outside foundation wall.
3. Conductor piping from roof drains to storm building drain.
4. Storm building drain piping from conductor piping and area drains to storm sewers 5 feet outside foundation wall.
5. Storm overflow piping from overflow drains.
6. Domestic cold water piping.
7. Domestic hot water piping.
8. Domestic circulating hot water piping.
9. Plumbing fixtures: See Section 22 40 00, Plumbing Fixtures, and schedule for types.
10. Specialty piping systems.
11. Condensate drain and water piping system for plumbing equipment.
12. Flashing and counterflashing of roof and wall penetrations, fixtures and the like and wall penetrations, fixtures and the like by installation of work of this Section.
13. Furnishing and installation of access doors required for work furnished by this Section.
14. Furnishing and installing of sleeves, inserts and anchorage required for the installation, which are embedded in work of other trades. Sleeve, wrap and seal piping in concrete.

### 1.2 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of plumbing system products, of types, materials, and sizes required.

B. Regulatory Requirements:
1. Codes: Comply with UPC pertaining to plumbing materials, construction and installation of products. Comply with local and state regulations.
2. ANSI Compliance: Comply with applicable American National Standards Institute Standards pertaining to products and installation.
3. PDI Compliance: Comply with applicable Plumbing and Drainage Institute standards pertaining to products and installation.

## PART 2 - PRODUCTS

### 2.1 SOIL, WASTE, VENT AND DRAINAGE PIPING

A. Underground Piping to 5 Feet Outside Building Line: "No-Hub" cast iron soil pipe and fittings with heavy-duty stainless steel couplings and neoprene gaskets.

B. Aboveground Piping: "No-Hub" cast iron soil pipe and fittings with standard-duty stainless steel couplings and neoprene gaskets.

## 2.2 DOMESTIC WATER PIPING

A. Above Ground: Type "K" copper tubing. Wrought copper or cast bronze sweat fittings.
   1. Piping 3 Inches and Above: Brazed or rolled grooved joint.
   2. Piping 2-1/2 Inches and Smaller: Soldered (95/5 solder) joints or rolled grooved to 2 inches.
   3. Approved Fillers:
      a. Pressure Range 81 to 150 PSI and Temperatures 151F to 200F: 95/5 tin-antimony or silver-bearing solders, i.e., Allstate 430, Harris Stay Brite 5 or 8.
      b. Use appropriate flux per manufacturer's recommendations. Use of corrosive fluxes is prohibited.

B. Below Ground: Type "K" copper tubing with brazed joints. Approved Fillers: "Phos-0," "Silfos 5," "Aircosil 15," "Braze 450(DE)." Use appropriate flux per manufacturer's recommendations.

## 2.3 PRIMER PIPING

A. Above Ground: Type "L" hard-drawn copper tubing with wrought sweat fittings and soldered joints.

B. Below Ground: Type "L" soft annealed copper tubing with wrought sweat fittings and brazed joints.

## 2.4 CONDENSATE DRAIN PIPING

A. Type "M" copper tubing and wrought copper or cast bronze sweat fittings. 95/5 soldered joints. On sizes 1-1/4 inches and larger, provide "DWV" pattern drainage fittings.

## 2.5 PUMP PRESSURE PIPING

A. Above Grade: Type "L" copper with solder joints.

B. Below Grade: Type "L" copper with brazed joints.

## 2.6 CLEANOUTS

A. General: Locate cleanouts as shown on Drawings and as required by local code. Cleanouts same size as pipe except that greater than 4 inches will not be required. Plastic components not allowed, except unless specifically noted.

B. Types:
   1. Tile Floor Cleanouts: J. R. Smith 4020-U with round heavy-duty nickel bronze top, taper thread, ABS plug and vandalproof screws.
   2. Carpeted Floor Cleanout: J. R. Smith 4020-U-X with carpet clamping frame with round heavy-duty nickel bronze top, taper thread, ABS plug, carpet clamping device and vandalproof screws.
   3. Concrete Floor Cleanout (General): J. R. Smith 4020 with round heavy-duty nickel bronze top, taper thread and ABS plug with vandalproof screws.

4. Concrete Floor Cleanout (Heavy Load): Same as for "General" locations, Item 3 above, except J. R. Smith 4100.
5. Wall Cleanout: J. R. Smith 4472-U, countersunk bronze taper thread plug, stainless steel shallow cover and vandalproof screws.
6. Outside Area Walks and Drives: J. R. Smith 4023-U with round heavy-duty nickel bronze top, taper thread, ABS plug and top secured with vandalproof screws. Install in 18- by 18- by 6-inch deep concrete pad flush with grade.

C. Manufacturers: J. R. Smith, Zurn, Wade, Watts, or approved. J. R. Smith model numbers used as a basis of selection.

## 2.7 VALVES

A. General:
1. End Connections: Mate with pipe, tube and equipment connections. Where more than one type is indicated, selection is installer's option.
2. Sizes: Unless otherwise indicated, provide valves of same size as upstream pipe sizes.
3. Refer to Section 22 05 23, General-Duty Valves for Plumbing for detailed valve specifications.

B. Service:
1. Domestic Hot and Cold Water Shutoff and Isolation Valves:
   a. Pipe Sizes 2-1/2 Inches and Smaller: Ball valve.
   b. Pipe Sizes 3 Inches and Larger: Gate valve or butterfly valve.
2. Drain Service; All Pipe Sizes: Drain valves.
3. Strainer Blow-Off: Ball valve.
4. Bypass Around Pressure-Reducing Valves: Globe valves.
5. Check Valves on Ejector (Sump) Pump Discharge: Swing check if horizontal installation.
6. Check Valves Other than Pump Discharge: Swing check.

C. Relief Valve: ASME code approved pressure and temperature relief valve. Run full size pipe to floor drain, or as noted otherwise. Cash-Acme, Watts, or approved.

D. Backwater Valves:
1. Inline: Cast iron body, bronze flapper valve, bolted cover. Jay R. Smith 7012. Wade, Zurn approved. Provide service access to cover.
2. Inline with Shutoff Valve: Similar to "Inline" except with internal bronze gate shutoff feature and removable wheel handle. Provide extension to finish grade for service access. Jay R. Smith 7150. Wade, Zurn approved.

## 2.8 WATER HAMMER ARRESTORS (SHOCK ABSORBERS)

A. Bellows-type, stainless steel casing and bellows, pressure rated, tested and certified in accordance with PDI WH-201. Manufacturers: Amtrol, Inc., J. R. Smith, Wade, Zurn, or approved.

B. Piston-type, copper, brass or stainless steel with O-ring piston, pressure rated, tested and certified in accordance with PDI WH-201. Manufacturers: PPP, Sioux Chief, or approved

## 2.9 FLASHING FLANGES

A. Cast iron watertight stack or wall sleeve with membrane flashing ring. Provide underdeck clamp and sleeve length as required.]

## 2.10 VENT FLASHING SLEEVES

A. Cast iron caulking type roof coupling for cast iron stacks, cast iron threaded type roof coupling for steel stacks, and cast bronze stack flashing sleeve for copper tubing.]

## 2.11 TRAP PRIMERS

A. Trap seal primer valve with integral automatic antisiphon protection. Code approval required. Wade, Zurn, J. R. Smith, PPP, or approved.

## 2.12 THERMOMETERS

A. 3-inch diameter bi-metal dial thermometer with stainless steel case, white dial, black numbers with 4-inch stainless steel stem and brass separable socket. Provide back or bottom connections as required. 0F to 200F range. Manufacturers: Weiss Model 3BMS, Palmer, Ashcroft, Trerice, Marshaltown, Weksler, or approved.

## 2.13 PRESSURE GAUGES

A. Single-pointer gauge with 0 to 160 range, 20 PSI intervals and 2 PSI increments intermediate graduations. Aluminum dial with 1 percent accuracy and low bottom connections for wall mounting. Manufacturers: Weiss, Palmer, Marshaltown, Trerice, Ashcroft, Weksler, U.S. Gauge, or approved.

## 2.14 BACKFLOW PREVENTERS

A. General: Provide shutoff valve and unions upstream and downstream of backflow preventers. Provide bronze "Y" strainer upstream of all backflow preventers. Note: For hot water applications of 140F or greater, provide backflow preventer rated for temperature of hot water system serving.

B. Atmospheric Vacuum Breaker: Watts Model 288A with Watts 777S "Y" strainer. Febco, Wilkins, or approved.

C. Pressure Vacuum Breaker: Watts Model 800MCQT with 777S "Y" strainer. Febco, Wilkins, Conbraco, or approved.

D. Double Check Backflow Preventer: Watts Model 007QT Series with strainer, Febco, Wilkins, Conbraco, or approved.

E. Reduced Pressure Backflow Preventer: Watts Model 909QT Series with strainer. Febco, Wilkins, Conbraco, or approved. Provide with air gap fitting and indirect drain piping to drain.

## 2.15 PREMANUFACTURED COUNTERFLASHINGS

A. Factory-fabricated counterflashing constructed from Schedule 40 galvanized steel or galvanized malleable iron pipe coupling with tapered threads and 3 lb. lead sheet lead formed and soldered to coupling to produce counterflashing minimum of 4-inch overlap over roof flashings. Provide for pipe sizes as required. Manufacturers: A&B Sheetmetal, 503-254-5581.

## 2.16 ACCESS PANELS

A. Provide flush-mounting access panels as required for service of fire dampers, cleanouts, valves, and the like, and other items requiring maintenance or inspection. Where access panels are located in fire-rated assemblies of building, rate access panels accordingly. Ceiling access panels to be minimum 24x24 (or required and approved size). Wall access panels to be minimum 12x12 (or required and approved size). Manufacturers: Milcor, Karp, Elmdor, In-Ryko, Acudor, or approved. Provide two keys for each set of locks provided.

# PART 3 - EXECUTION

## 3.1 DRAIN PIPING

A. General: Lay underground building drains beginning at low point of systems, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install required gaskets in accordance with manufacturer's recommendations for use of lubricants, cements, and other special installation requirements. Clean interior of piping of dirt and other superfluous materials as work progresses. Maintain swab or drag in line and pull past each joint as it is completed. Place plugs in ends of uncompleted piping at end of day or whenever work stops. Coordinate installation of piping below with structural components and other system installations.

B. Install piping pitched to drain at minimum slope of 1/4 inch per foot (2 percent). Where this slope is impractical, slope at 1/4 inch per foot for pipes below 4-inch size, and 1/8 inch per foot (1 percent) for piping 4 inches and larger, with the approval of the local code authority having jurisdiction.

C. Condensate Drain Piping at HVAC-Units: Trap condensate drain for HVAC units in accordance with Detail on Plumbing Drawings.

## 3.2 CLEANOUTS

A. Install in aboveground piping and building drain piping as indicated, as required by code; at each change in direction of piping greater than 135 degrees; at minimum intervals of 100 feet; and at base of each vertical soil or waste stack. Install floor and wall cleanout covers for concealed piping. Select type to match adjacent building finish. Coordinate locations and types of cleanouts with Architect prior to installation.

## 3.3 FLASHING FLANGES

A. Install flashing flange and clamping device with each stack and cleanout passing through waterproof membranes.]

## 3.4 VENT FLASHING SLEEVE

A. Install on stacks passing through roof, secure over stack flashing in accordance with manufacturer's instructions. Coordinate with roofing system.]

## 3.5 EQUIPMENT CONNECTIONS

A. Provide soil and waste piping runouts to plumbing fixtures and drains, with approved trap, of sizes indicated; but in no case smaller than required by code.

B. Locate piping runouts as close as possible to bottom of floor slab supporting fixtures or drains.

C. Piping Runouts to Fixtures: Provide hot and cold piping runouts to fixtures of sizes indicated, but in no case smaller than required by code.

D. Mechanical Equipment Connections: Connect hot and cold water piping system to plumbing equipment as indicated, and comply with equipment manufacturer's instructions. Provide shutoff valve and union for each connection; provide drain valve on drain connection.

## 3.6 DOMESTIC WATER DISTRIBUTION PIPING

A. Water Service Piping: Provide sleeve in foundation wall for water service entry; make entry watertight. Provide shutoff valve at water service entry inside building; pressure gauge, test tee with valve.

B. Water Hammer Arrestors: Install in upright position, in locations and of sizes in accordance with PDI WH-201, and elsewhere as indicated.

C. Group piping installations and valves where possible to obtain maximum practical use of available space.

D. Arrange locations of valves, unions, drains and other components to provide for ease of cleaning, operation, repair or service. Size access panels and locate to provide both acceptable proximity and working space for such devices.

E. Provide valves and shock arrestors where required by code and where otherwise indicated in Specifications and on Drawings.

F. Provide protection plates for piping installed in wood stud walls and other building substructures as required by code.

G. Wherever piping is installed in exterior walls, route on warm side of insulation and as close to inside wall finish as possible, as detailed.

H. Provide low point drains and shutoff valves as required by local AHJ. Provide valve boxes, access panels, and the like, for complete installation.

## 3.7 VALVES

A. Backwater Valves: Provide rectangular concrete valve box with cast iron hinged locking access cover, labeled "Backwater Valve". Provide size adequate for depth, maintenance accessibility for valve assembly, and the like. Provide extensions as required. Set flush with finish grade.

## 3.8 BACKFLOW PREVENTERS

A. Install where indicated, and where required by code. Where practical, locate in same room as equipment being protected.

B. Submit product cut sheets to local AHJ for approval prior to purchase.

C. Install as close to wall as possible with clearances for access and maintenance as required by AHJ.

D. Coordinate exact location of installation and type of backflow device serving a particular piece of equipment with AHJ and Architect prior to purchase and installation.

E. Provide wall/floor brackets that are of fully welded, hot dipped galvanized construction, fabricated to meet field conditions. Mount backflow preventer to brackets using cadmium plated "U" type bolts and nuts.

F. Contact: Contact local water district/backflow specialist and request backflow installation literature. Install backflow devices per UPC and local water district/backflow specialist requirements.

G. Route waste piping from air gap waste fitting concealed within walls to point of air gap termination at indirect waste receptor.

## 3.9 EXCAVATION AND BACKFILL

A. General: Perform necessary excavation and backfill required for installation of plumbing work. Repair piping or other work at no expense to Owner.

B. Water: Keep excavations free of standing water. Reexcavate and fill back excavations damaged or softened by water or frost to original level with sand, crushed rock or other approved material at no expense to Owner.

C. Tests: During progress of work for compacted fill, Owner reserves right to request compaction tests made under direction of a testing laboratory.

D. Trench Excavation: Excavate trenches to necessary depth and width, removing rocks, unstable soil (muck, peat, and the like), roots and stumps. Excavation material is classified as "base fill" and "native." Base fill excavation material consisting of placed crushed rock may be used as backfill above "Pipe Zone." Remove and dispose off site native excavation material. Adequate width of trench for proper installation of piping or conduit.

E. Support Foundations:
   1. Foundations: Excavate trenches located in unstable ground areas below elevation required for installation of piping to a depth which is determined by Architect as appropriate for conditions encountered. Place and compact approved foundation material in excavation up to "Bedding Zone." Dewatering, placement, compaction and disposal of excavated materials to conform to requirements contained in other sections of Specifications or Drawings.
   2. Over-Excavations: Where trench excavation exceeds required depths, provide, place and compact suitable bedding material to proper grade or elevation at no additional cost to Owner.

3. Foundation Material: Where native material has been removed, place and compact necessary foundation material to form a base for replacement of required thickness of bedding material.

| | Class A | | Class B | |
|---|---|---|---|---|
| Material Passing: | Min. | Max. | Min. | Max. |
| 3/4-inch Square Opening | 27 | 47 | 0 | 1 |

4. Bedding Material: Full bed piping on sand, pea gravel, or 3/4-inch minus crushed rock. Place a minimum 4-inch deep layer of sand, pea gravel, or crushed rock on leveled trench bottom for this purpose. Remove bedding to necessary depth for piping bells and couplings to maintain contact of pipe on bedding for its entire length. Provide additional bedding in excessively wet, unstable, or solid rock trench bottom conditions as required to provide a firm foundation.

F. Backfilling:
1. Following installation and successful completion of required tests, backfill piping in lifts.
   a. In "Pipe Zone" place backfill material and compact in lifts not to exceed 6 inches in depth to a height of 12 inches above top of pipe. Place backfill material to obtain contact with entire periphery of pipe, without disturbing or displacing pipe.
   b. Place and compact backfill above "Pipe Zone" in layers not to exceed 12 inches in depth.
2. Backfill Material:
   a. Backfill Material in "Pipe Zone": 3/4-inch minus crushed rock, sand or pea gravel.
   b. Crushed rock, fill sand or other backfill material approved elsewhere in Specifications may be used above "Pipe Zone."

G. Compaction of Trench Backfill:
1. Where compaction of trench backfill material is required, use one of following methods or combination thereof:
   a. Mechanical tamper,
   b. Vibratory compacter, or
   c. Other approved methods appropriate to conditions encountered.
2. Architect to have right to change methods and limits to better accommodate field conditions. Compaction sufficient to attain 95 percent of maximum density at optimum moisture content unless noted otherwise on Drawings or elsewhere in Specifications. Water "puddling" or "washing" is prohibited.

## 3.10 PIPE INSTALLATION

A. Seismic Restraint: Brace plumbing piping and plumbing equipment against lateral movement as detailed in document "Seismic Restraint Manual Guidelines for Mechanical Systems" as published by SMACNA.

B. Rough-in Piping: Provide temporary caps or plugs at piping shown on Drawings to be roughed-in for future connections by others.

C. Sanitary Waste and Storm Drain Piping: Slope at uniform grade of 1/4 inch per foot unless noted otherwise. Make changes in size with reducing and wye fittings. Run exposed piping parallel or perpendicular to building structure.

D. Underground Preinsulated Piping System:
1. Take care to ensure the installed system is completely watertight.

2. Install pipes and accessories in accordance with the manufacturer's recommendations.
3. After anchor blocks are poured and cured, a hydrostatic test of 150 PSIG or 1-1/2 times operating pressure, whichever is greater, required for a period of 4 hours.
4. Backfill: Follow manufacturer's recommendations.

E. Vent Piping:
1. General: Horizontal runs free of drops and sloped to drainage system.
2. Vents-Through-Roof (VTRs): Provide 3 lb. flashing with counterflashing at vent penetrations through roof, as detailed. Wherever vents run up near or inside of exterior walls, offset pipe at underside of roof deck to obtain minimum 5 foot clearance between parapet and roof penetration. Provide code required clearances between vent-through-roof and HVAC equipment on roof. VTR counterflashings to have a manufactured rolled return bend with minimum 1-inch overlap; crimping by hand tools will not be allowed. On single ply vinyl or plastic type roofs, provide flashings as required by roof installer and manufacturer. On raised rib steel roofs, provide flashings as required by roof installer and manufacturer.

## 3.11 TESTING

A. General:
1. Provide temporary equipment for testing, including pumps, compressors, tanks, and gauges, as required. Test piping systems before insulation (if any) is installed and remove or disengage control devices before testing. Where necessary, test sections of each piping system independently, but do not use piping valves to isolate sections where test pressures exceed local valve operating pressure rating. Fill each section with water, compressed air, or nitrogen and pressurize for the indicated pressure and time.
2. Notify Architect and local Plumbing Inspector 2 days before tests.
3. Drainage, Waste and Vent Piping: Test in accordance with governing plumbing code or as follows: Test drainage and venting systems, with necessary openings plugged, to permit system to be filled with water and subjected to a water pressure of a minimum of 5 PSI head. System to hold water without a water level drop greater than 1/2 pipe diameter of largest nominal pipe size within a 24-hour period. Test system in sections if minimum head cannot be maintained in each section. The 5 PSI head to be the minimum pressure at the highest joint.
4. Water Piping: Eliminate air from system. Fill and test at 125 PSIG or minimum 1-1/2 times static pressure at connection to serving utility main for a period of two hours with no loss in pressure.
5. Send test results to Architect for review and approval.

B. Testing of Pressurized Systems:
1. Test each pressurized piping system at 150 percent of operating pressure indicated, but not less than 125 PSIG test pressure.
2. Observe each test section for leakage at end of test period. Test fails if leakage is observed or if pressure drop exceeds 2 percent of test pressure.

C. Test hot and cold domestic water piping systems upon completion of rough-in and before connection to fixtures at a hydrostatic pressure of 125 PSIG.

## 3.12 WATER HAMMER ARRESTORS (SHOCK ABSORBERS)

A. Locate shock absorbers in supply pipe in accordance with recommendations of Plumbing and Drainage Institute PDI-WH201. Install ahead of solenoid operated valves. Determine size of absorber by fixture unit value of fixture supplied, using PDI symbols to designate sizes. Provide access panel for each shock absorber.

## 3.13 ADJUSTING AND CLEANING

A. Piping: Clean piping exterior surfaces. Comply with Section 22 07 00, Plumbing Insulation, as applicable. Flush out water-filled or drainage piping systems with clean water.

## 3.14 HOSE BIBB PIPING

A. Provide each hose bibb with an individual accessible shutoff valve (ball type). Locate where shown on Drawings.

## 3.15 CHLORINATION

A. General: Upon completion of tests and necessary replacements, thoroughly flush and disinfect domestic water piping.

B. Method: After thoroughly flushing system with water to remove sediment, fill system with a solution containing 50 parts per million of chlorine for not less than 24 hours or 200 parts per million of chlorine for not less than 3 hours. After retention, drain, reflush and return system to service.

C. Certification: Provide copy of domestic water chlorination certificate in each operations and maintenance manual.

## 3.16 PROTECTION

A. Keep pipe openings closed by means of plugs or caps to prevent the entrance of foreign matter. Protect piping, ductwork, fixtures, equipment and apparatus against dirty water, chemical or mechanical damage both before and after installation. Restore to its original condition or replace fixtures, equipment or apparatus damaged prior to final acceptance of the work.

## 3.17 ACCESS PANELS

A. Install ceiling or wall access panels to provide access to concealed valves, motors, shock arrestors, and other plumbing items needing service. Provide access panels at locations required or as specified herein. Coordinate locations/sizes of access panels with Architect prior to work.

**END OF SECTION**

# SECTION 22 30 00

# PLUMBING EQUIPMENT

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Work Included:
1. Water heaters.
2. Grease interceptors.
3. Grease traps.
4. Circulation pumps.
5. Duplex ejector basin.
6. Booster pumps.
7. Storage tanks.
8. Sump pumps.
9. Acid neutralization tanks.
10. Expansion tanks.
11. Water softeners.

### 1.2 QUALITY ASSURANCE

A. Refer to Section 22 00 00, Plumbing Requirements.

B. Water Heaters:
1. Water heaters and storage tanks to meet current energy efficiency code requirements and be provided with anode rod corrosion protection, internal glass lining, insulated steel jacket with baked enamel finish, and pressure-temperature relief valve to match tank working pressure. Rate water heaters at 150 PSIG working pressure; rate storage tanks at 125 PSI working pressure. Copper fin tube heat exchanger to meet energy code requirements and bear ASME code symbol. Rate copper fin tube heat exchanger at 160 PSIG working pressure and provide with pressure/temperature relief valve compatible with storage tank working pressure requirements. Refer to Schedule on Drawings for capacity and model.
2. ANSI Compliance: Comply with ANSI Z223.1 (NFPA 54) "National Fuel Gas Code," as applicable to installation of gas-fired water heaters.
3. CSA and NSF Labels: Provide water heaters which have been listed and labeled by CSA and NSF.
4. ASME Code Symbol Stamps: For applicable equipment, comply with ASME Boiler and Pressure Vessel Code for construction, and stamp with ASME code symbol.

C. Commercial Water Heaters:
1. ASME Relief Valve Stamps: Provide water heaters and water tanks with safety relief valves bearing ASME valve markings.
2. Code Compliance: Comply with the UPC and ASHRAE/IESNA 90.1.
3. PDI Compliance: Comply with applicable Plumbing and Drainage Institute Standards pertaining to factory-fabricated water heaters.

D. Pumps:
1. HI Compliance: Design, manufacture and install pumps in accordance with HI "Hydraulic Institute Standards."

2. UL Compliance: Design, manufacture and install in accordance with UL 778 "Motor-Operated Water Pumps."

## 1.3 SUBMITTALS

A. Product Data in Accordance with Division 01: Manufacturer's specifications, installation and startup instructions, capacity and ratings, with selection indicated. Provide pump performance curves with selection points indicated. Provide specialties and accessories required for a complete and operable installation.

B. Shop Drawings:
1. Assembly type shop drawings indicating dimensions, weights, required clearances, and methods of assembly of components and anchorages.
2. Submit For:
   a. Water heaters.
   b. Grease interceptors.
   c. Grease traps.
   d. Circulation pumps.
   e. Duplex ejector basin.
   f. Booster pumps.
   g. Storage tanks.
   h. Sump pumps.
   i. Expansion tanks.
   j. Water softeners.

C. Wiring Diagrams: Ladder type wiring diagrams for components, indicating required field electrical connections.

D. Maintenance Data: Submit maintenance data and parts list for each item. Include "troubleshooting" maintenance guides. Include this data in operation and maintenance manual.

# PART 2 - PRODUCTS

## 2.1 CIRCULATION PUMPS

A. General: Provide in-line factory tested pumps, cleaned, and painted with enamel prior to shipment. Provide pumps of same type by same manufacturer.

B. Type: Horizontal, oil-lubricated, designed for 125 PSI working pressure, 210F continuous water temperature.

C. Body: Bronze or stainless steel construction.

D. Shaft: Steel, ground and polished, integral thrust collar.

E. Bearings: Two horizontal sleeve bearings designed to circulate oil.

F. Seal: Mechanical, with carbon seal face rotating against ceramic seat.

G. Motor: Nonoverloading at any point on pump curve, open, dripproof, sleeve bearings, quiet operating, rubber mounted construction, built-in thermal overload protection.

H. Coupling: Self-aligning, flexible.

I. Manufacturers: Amtrol, Armstrong, Bell & Gossett, Grundfos, Paco, Taco, or approved.

## 2.2 STORAGE TANKS

A. ASME storage tank. Capacity and size to be as shown on Drawings. Tank constructed and stamped according to ASME Specifications for 125 PSI working pressure. Include manhole and inspection openings in accordance with ASME code requirements and manufacturer's standard practice (except on glass lined, galvanized or cement lined). Tank to be constructed of carbon steel. Epoxy lining. Equip tank with the number and size of magnesium anode rod sufficient to provide adequate protection for the tank lining. Tank to be vertical design and provided with four angle iron legs.

B. Manufacturers: Ace, A. O. Smith, State, Bradford-White, RayPak, or approved.

## 2.3 EXPANSION TANKS ASME

A. Manufacturers: Mueller, Amtrol, Armstrong, Taco, Bell & Gossett, or approved.

B. Welded steel, constructed, tested and stamped in accordance with ASME Boiler and Pressure Vessel Code for working pressure of 125 PSI. Support floor mounted tanks with steel legs or base. Provide single flexible diaphragm securely sealed into tank to separate air charge from system water, to maintain design expansion capacity. Provide pressure gauge and air-charging fitting, and drain fitting. Diaphragm: Removable and replaceable in line.

# PART 3 - EXECUTION

## 3.1 WATER HEATERS

A. Gas-Fired Water Heaters:
1. General: Install in accordance with manufacturer's installation instructions.
2. Support: Set units on concrete pads, orient so controls and devices needing service and maintenance have adequate access. Level and plumb unit.
3. Gas Supply: Connect to gas line with drip leg, tee, gas cock, and union; full size of unit inlet connection. Locate piping so as not to interfere with service of unit.
4. Piping: Connect hot and cold water piping to units with shutoff valves and unions. Connect recirculating water line to unit with shutoff valve; check valve, and union. Pipe relief valve discharge full size to floor drain.
5. Flue: Connect flue to draft hood with gastight connection.
6. Startup: Start up, test, and adjust gas-fired water heaters in accordance with manufacturer's startup instructions, and utility company's requirements. Check and calibrate controls, adjust burner for maximum efficiency.
7. Seismic Restraint: Anchor tanks to structure.

B. Electric Water Heaters:
1. General: Install in accordance with manufacturer's installation instructions.
2. Support: Set units on insulated pads meeting energy code requirements, orient so controls and devices needing service and maintenance have adequate access. Level and plumb unit.
3. Piping: Connect hot and cold water piping to units with shutoff valves and unions. Connect recirculating water line to unit with shutoff valve; check valve, and union. Pipe relief valve discharge full size to floor drain.
4. Startup: Start up, test, and adjust electric water heaters in accordance with manufacturer's startup instructions, and utility company's requirements. Check and calibrate controls.
5. Seismic Restraint: Anchor tanks to structure utilizing methods outlined in Contract Documents as required by governing authorities.

## 3.2 CIRCULATING PUMPS

A. Install per manufacturer's instructions.

B. Adjust flow rate to design point.

## 3.3 EXPANSION TANKS

A. Install tank in accordance with manufacturer's instructions. Charge tank with air per manufacturer's instructions.

## 3.4 PROTECTION

A. Protect bright finished shafts, bearing housings and similar items, until in service; no rust will be permitted.

B. Cover equipment and materials stored on the job site or otherwise suitably protect at the direction of, and to the satisfaction of Architect. If coverings become torn, replace until the equipment is connected and operating.

**END OF SECTION**

# SECTION 22 40 00

# PLUMBING FIXTURES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Provide labor, materials, equipment and services necessary to furnish and install a complete plumbing system as shown on the Drawings and specified herein. The work includes, but is not necessarily limited to:

1. Plumbing fixtures and trim, including rims for sinks and lavatories in casework or counters, chair carriers (as required), drinking fountain, drains, cleanouts, floor sinks, and related fixtures shown on the Drawings.
2. Rough-in and final connection to equipment and fixtures, relocated or provided under other sections or under other divisions of the work.
3. Standards and supports for equipment requiring them.
4. Instructions and maintenance manuals for equipment furnished by this Section.
5. Electrical: For plumbing trim/fixtures (sensor type faucets/flushometers, and the like, provide, from the 120-volt connection by Division 26 to the plumbing equipment, low voltage electrical connections and wiring as required for complete and operable system. Includes, but is not limited to low voltage electrical raceway, wiring and accessories, such as step-down transformers as necessary for function of sensors and automatic valve and faucet controls. Supply step-down transformers and size wiring as recommended by manufacturer of plumbing equipment requiring low voltage electrical connection.

### 1.2 SUBMITTALS

A. Product Data in Accordance with Division 01: Manufacturer's specifications, installation and startup instructions, capacity and ratings, with selection indicated. Provide pump performance curves with selection points indicated. Provide specialties and accessories required for a complete and operable installation.

B. Shop Drawings:

1. Assembly type shop drawings indicating dimensions, weights, required clearances, and methods of assembly of components and anchorages.
2. Submit For:
   a. Fixtures, see Plumbing Fixture Schedule.
   b. Floor and roof drains.
   c. Trench drains.

C. Wiring Diagrams: Ladder type wiring diagrams for components, indicating required field electrical connections.

D. Maintenance Data: Submit maintenance data and parts list for each item. Include "troubleshooting" maintenance guides. Include this data in maintenance manual.

### 1.3 DELIVERY, HANDLING AND STORAGE

A. Fixtures: Deliver plumbing fixtures individually wrapped in factory fabricated containers. Handle plumbing fixtures carefully to prevent breakage, chipping and scoring fixture finish. Do not install damaged plumbing fixtures; replace and return damaged units to equipment manufacturer.

## PART 2 - PRODUCTS

### 2.1 PLUMBING FIXTURES

A. General: Provide factory fabricated fixtures of type, style and material indicated on the Plumbing Fixture Schedule on the Drawings. For each type fixture, provide fixture manufacturer's standard trim, carrier, seats, and valves as indicated by their published product information; either as designed and constructed, or as recommended by manufacturer, and as required for complete installation. Where more than one type is indicated, selection is installer's option; but, fixtures of same type must be furnished by a single manufacturer. Where type is not otherwise indicated, provide fixtures complying with governing regulations.

1. Fixtures: Complete with fittings, supports, fastening devices, faucets, valves, traps, stops and appurtenances required.
2. Exposed IPS Piping and Tubing: Brass, chrome plated.
3. Escutcheons: Brass, chrome plated.
4. Fixture Locations: As shown on Drawings.
5. Stops: Stops installed in each supply pipe at each fixture accessibly located with wall escutcheons.
6. Showers: Provide with flow control device to prevent flow over 2.5 GPM.
7. Public Lavatories: Provide with flow control device to prevent flow over 0.5 GPM.
8. Interior Faucets except Public Lavatories: Provide with flow control device to prevent flow over 2.5 GPM.
9. Bathtubs: Provide waste and overflow assembly with soldered or solvent weld joints. Provide per fire rating of building assemblies.

## PART 3 - EXECUTION

### 3.1 VERIFICATION OF CONDITIONS

A. Fixtures: Examine roughing-in work of potable water and waste piping systems to verify actual locations of piping connections prior to installing fixtures. Examine floors and substrates, and conditions under which fixture work is to be accomplished. Correct any incorrect locations of piping and other unsatisfactory conditions for installation of plumbing fixtures.

### 3.2 FIXTURES INSTALLATION

A. General:

1. Install plumbing fixtures of types indicated where shown and at indicated heights; in accordance with fixture manufacturer's written instructions, roughing-in drawings, and with recognized industry practices. Ensure that plumbing fixtures comply with requirements and serve intended purposes.
2. Set and connect to soil, waste, vent and water piping in neat, finished and uniform manner. Connections to be equal height, plumb and set at right angles to floor, wall or both unless otherwise required or specified.
3. Seal fixtures mounted on floors and walls at abutting joints with approved sealant compounds as directed by Architect.
4. For ADA accessible toilets, provide with actuator at wide portion of stall.
5. Lavatories: Set mixing valves to limit outlet temperature to 110F.

B. Fixture Locations: As shown on Drawings. Center water closets and urinals between privacy partitions unless noted otherwise.

C. Stops: Stops installed in each supply pipe at each fixture accessibly located with stops of loose key type. Concealed stops to be screwdriver or loose key type with wall

escutcheons.

D. Fixture Supports:
1. Support wall hung water closets, urinals and lavatories on heavy duty, full size, concealed, commercial grade carriers mounted to floor structure. Refer to Plumbing Fixture Connection Schedule on Drawings.
2. Support other fixtures mounted on stud partitions on heavy concealed wall brackets bolted to a ¼-inch thick by 5-inch high steel plate anchored firmly to studs with bolts (or welded to metal studs). Plate to extend one stud each way beyond fixture mounting point width.

E. Flush Valves: Provide "drop-ear" ells or couplings in wall at water supply outlets to flush valves; anchor firmly to structure.

F. After fixtures are set in place and secured to walls, caulk all around between fixtures and wall with white silicone caulking compound. Dow Corning 780, General Electric Construction Sealant, or approved.

G. Set countertop lavatories and stainless steel sink rims in waterproof sealant made for application.

H. Adjust self-closing faucets to provide minimum of 10 seconds of waterflow, and maximum of 15 seconds.

I. After fixture installation is complete, cover and protect rims, fronts and exposed parts until completion of construction phase. Contractor responsible for damage to fixtures and assumes related fixture repair or replacement costs.

J. At ADA accessible drinking fountains/water coolers, set at heights required for ADA compliance. See Architectural Drawings for bi-level fixtures. Provide right/left high/low orientation to match installation. Provide apron/skirt as required.

## 3.3 FLOOR DRAINS AND FLOOR SINKS

A. General: Install drains in accordance with manufacturer's written instructions and in locations indicated.

B. Coordinate with piping as necessary to interface drains with drainage piping systems.

C. Install floor drains at low points of surface areas to be drained, or as indicated. Set tops of floor drains flush with finished floor. Set floor sinks as required by local codes.

D. Install drain flashing collar or flange so that no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.

E. Position drains so that they are accessible and easy to maintain.

F. Coordinate drain flashing, flanges and strainer types and depths with floor substrate and topping configuration.

G. Primers:
1. Prime drains. Refer to Drawings and coordinate location with Architect. Coordinate with local AHJ for exact requirements.
2. Primer Locations:
a. Drains in Food Areas: PPP-type trap-priming. Do not install primer valves above ceiling. Coordinate trap primer locations with Architect/Engineer. If installed in wall, provide access panel and

coordinate exact panel location.

b. Public Restrooms: Primer connection at water closet flush valve tailpiece connects to rear of pipe using chrome-plated piping at exposed locations.

c. All Other Areas: PPP-type trap-priming valve. Do not install primer valves above ceiling. Coordinate trap primer locations with Architect/Engineer. If installed in wall, provide access panel and coordinate exact panel location with Architect.

## 3.4 ROOF DRAINS/OVERFLOW DRAINS

A. General: Install drains in accordance with manufacturer's written instructions and in locations indicated.

B. Provide four pound lead flashing and coordinate flashing work with work of roofing, waterproofing, and adjoining substrate work.

C. Coordinate with roofing as necessary to interface roof drains with roofing work.

D. Coordinate with storm water piping as necessary to interface drains with drainage piping systems.

E. Install drains at low points of surface areas to be drained.

F. Install drains flashing collar or flange so that no leakage occurs between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.

G. Position drains so that they are accessible and easy to maintain.

H. Set overflow drains at proper elevation relative to main roof drains.

I. Install flexible expansion joints on roof drains which do not have horizontal offsets at storm drainage piping.

## 3.5 HOSE BIBBS (INSIDE)

A. Install on exposed piping where indicated, with vacuum breaker.

## 3.6 HOSE BIBBS AND HYDRANTS

A. Install where indicated, with vacuum breaker and in accordance with manufacturer's installation instructions.

## 3.7 ADJUSTING AND CLEANING

A. Clean plumbing fixtures, trim, and strainers of dirt and debris upon completion of installation. Adjust water pressure at drinking fountains, faucets, shower valves and flush valves to provide proper flow stream and specified GPM. Repair leaks at faucets and stops.

## 3.8 FIELD QUALITY CONTROL

A. Inspection:

1. Upon completion of installation of plumbing fixtures and after units are water pressurized, test fixtures to demonstrate capability and compliance with requirements. When possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units and

proceed with retesting.

2. Inspect each installed unit for damage to finish. If feasible, restore and match finish to original at site; otherwise, remove fixture and replace with new unit. Feasibility and match to be judged by Architect. Remove cracked or dented units and replace with new units.

## 3.9 OWNER-FURNISHED EQUIPMENT

A. Not applicable

## 3.10 PROTECTION

A. Protect fixtures and equipment from damage. Replace damaged items with new.

**END OF SECTION**

# SECTION 23 00 00

# BASIC HVAC REQUIREMENTS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Work Included: Work included in 23 00 00 applies to Division 23 work to provide materials, labor, tools, permits and incidentals to provide and make ready for Owner's use heating, ventilation, and air conditioning systems for proposed project.

B. Related Work Specified Elsewhere:
1. Contents of Section applies to Division 23 specifications.
2. Requirements of Section are a minimum for Division 23 Sections, unless otherwise stated in each Section, in which case that Section's requirements take precedence.

### 1.2 DEFINITIONS

A. Following is a list of abbreviations generally used in Division 23:

| | | |
|---|---|---|
| 1. | ADA | Americans with Disabilities Act. |
| 2. | AHJ | Authority Having Jurisdiction. |
| 3. | ANSI | American National Standards Institute. |
| 4. | ARI | Air-Conditioning & Refrigeration Institute. |
| 5. | ASHRAE | American Society of Heating, Refrigerating and Air-Conditioning Engineers. |
| 6. | ASME | American Society of Mechanical Engineers. |
| 7. | ASTM | American Society for Testing and Materials. |
| 8. | ASSE | American Society of Sanitary Engineering. |
| 9. | AWWA | American Water Works Association. |
| 10. | CBC | California Building Code. |
| 11. | CEC | California Electrical Code. |
| 12. | CGA | Canadian Gas Association. |
| 13. | CMC | California Mechanical Code. |
| 14. | CISPI | Cast Iron Soil Pipe Institute. |
| 15. | CSA | Canadian Standards Association. |
| 16. | ETL | Electric Testing Laboratories. |
| 17. | FM | FM Global. |
| 18. | HI | Hydraulic Institute Standards. |
| 19. | HVAC | Heating, Ventilating and Air Conditioning. |
| 20. | MSS | Manufacturers Standardization Society. |
| 21. | NEC | National Electric Code. |
| 22. | NEMA | National Electrical Manufacturers Association. |
| 23. | NFGC | National Fuel Gas Code. |
| 24. | NFPA | National Fire Protection Association. |
| 25. | NRCA | National Roofing Contractors Association. |
| 26. | NSF | National Sanitation Foundation. |
| 27. | OSHA | Occupational Safety and Health Administration. |
| 28. | SMACNA | Sheet Metal and Air Conditioning Contractors' National Association, Inc. |
| 29. | TEMA | Tubular Exchanger Manufacturers Association. |
| 30. | TIMA | Thermal Insulation Manufacturers Association. |
| 31. | UL | Underwriters Laboratories Inc. |

B. Provide: To furnish and install, complete and ready for the intended use.

C. Furnish: Supply and deliver to the project site, ready for unpacking, assembly and installation.

D. Install: Includes unloading, unpacking, assembling, erecting, installation, applying, finishing, protecting, cleaning and similar operations at the project site as required to complete items of work furnished by others.

## 1.3 ADDITIONAL REQUIREMENTS TO DIVISION 01

A. Operation and Maintenance Documentation: Copies of certificates of code authority acceptance, test data, parts lists, maintenance information for equipment, valves, balancing reports, and other special guarantees, certificates of warranties, and the like, specified elsewhere herein or indicated on Drawings

B. Shop Drawings: Provide shop drawings which include physical characteristics, electrical characteristics, device layout plans, wiring diagrams, and the like. Refer to individual Specification Sections for additional requirements for the shop drawings.

C. Close-out Documentation: Submit mechanical code authority certification of inspection.

D. Record Drawings:
1. Show changes and deviations from the Drawings. Include issued Addendum and change order items.
2. Make changes to the Drawings in a neat, clean, and legible manner.

E. Product Data:
1. Submit manufacturer's technical data, installation instructions and dimensioned drawings for products, equipment and devices installed, supplied or provided. Refer to individual specification sections for specific items required in product data submittal. Submit at one time in 3-ring binder, tabbed and referenced to match the Contract Documents.
2. Maintain an updated product submittal package to be included in the final operation and maintenance documentation.

## 1.4 QUALITY ASSURANCE

A. Where Contract Documents are at variance with applicable codes governing work, code and local jurisdiction requirements take precedence, and include cost necessary for code compliance or local jurisdiction compliance in bid price. Machinery and equipment to comply with Occupational Safety and Health Act of 1970, as currently revised, as interpreted for equipment manufacturer requirements.

B. Mechanical Drawings: Drawings are intended to be diagrammatic and are based on one manufacturer's equipment. They are not intended to show every item in its exact dimensions, or details of equipment or proposed systems layout. Verify actual dimensions of systems (i.e., ducts and piping) and equipment proposed to assure that systems and equipment will fit in available space. Contractor is responsible for design and construction costs incurred for equipment other than basis of design, including but not limited to architectural, structural, electrical, fire sprinkler, and HVAC.

C. Requirements: As a minimum requirement, work in accordance with following rules and regulations and applicable laws:
1. NFPA.
2. OSHA.
3. Related supplements and standards.
4. California State Energy Code.
5. California Building Code.

6. California Mechanical Code.
7. California Plumbing Code.
8. California Fire Code.
9. State of California and local jurisdictional requirements.

D. Permits and Inspections:
1. Unless otherwise distinctly hereinafter specified, apply and pay for necessary permits, plans check, and inspections required by public AHJ.
2. Refer to General and Supplementary Conditions for payment of water and sewer service connection fees.
3. Obtain certificates of inspection from AHJs and deliver to Owner before final acceptance.
4. Each trade to consult local building department and utility companies prior to commencement of work to ascertain existence and location of existing underground utilities. Protect existing service against damage and interruption of use, and reroute as may be necessary to accomplish new work. Include costs for materials and installation for rerouting as specified for new work in bid price.

E. Regulatory Requirements:
1. UL and CSA Compliance: Provide units which are UL, ETL, and CSA listed.
2. ASME Compliance: Provide units which are ASME listed when boilers which exceed 200,000 BTUH, hot water storage tanks which exceed 120 gallons, and hot water expansion tanks which are connected to ASME rated equipment or required by code or local jurisdiction.

## 1.5 SEQUENCING AND SCHEDULING

A. For proper execution of work cooperate with other trades as needed.

B. To avoid installation conflicts, thoroughly examine complete set of Contract Documents. Resolve conflicts with Architect prior to fabrication and installation.

C. Prior to installation of equipment requiring electrical connections, examine manufacturer's shop drawings, wiring diagrams, product data, and installation instructions. Verify that electrical characteristics indicated in Contract Documents are consistent with electrical characteristics of actual equipment being installed. When inconsistencies occur request clarification from Architect.

## 1.6 COORDINATION DOCUMENTS

A. Prepare and submit coordinated layout drawings, prior to construction, to coordinate installation and location of HVAC equipment, ductwork, grilles, diffusers, piping, fire sprinklers, lights, and electrical services. Composite Drawings show services on single sheet. Key Drawings to structural column identification system, and progressively number. Prior to completion of Drawings, coordinate proposed installation with architectural and structural requirements, and other trades (including electrical, ceiling suspension, and tile systems), and provide reasonable maintenance access requirements.

B. Prepare Drawings as follows:
   1. Prepare Drawings to accurate scale of 1/4 inch = 1 foot or larger on Mylar sheets or AutoCAD. Drawings are to be same size as Contract Drawings and to indicate location, size and elevation above finished floor of HVAC equipment, ductwork, and piping. Drawings to also indicate proposed ceiling grid and lighting layout as shown on electrical drawings and reflected ceiling drawings.
   2. Review and revise as necessary section cuts in Contract Drawings after verification of field conditions.
   3. Indicate system piping including fittings, hangers, access panels, valves, and bottom of pipe elevations above finished floor.
   4. Piping that must be graded to have right-of-way over more flexible items.
   5. Drawings are to incorporate Addenda items and change orders.
   6. Distribute drawings to trades and provide additional coordination as needed.

C. Advise Architect, in event a conflict occurs in location or connection of equipment. Bear costs resulting from failure to properly coordinate installation or failure to advise Architect of conflict.

D. Verify in field exact size, location, invert, and clearances regarding existing material, equipment and apparatus, and advise Architect of discrepancies between that indicated on Drawings and that existing in field prior to installation related thereto.

E. Final coordination drawings with appropriate information added to be submitted as Record Drawings at completion of project.

## 1.7 COORDINATION DOCUMENTS

A. Prior to construction, coordinate installation and location of HVAC equipment, ductwork, grilles, diffusers, piping, lights, and electrical services with architectural and structural requirements, and other trades (including electrical, ceiling suspension, and tile systems), and provide reasonable maintenance access requirements.

## 1.8 EXISTING SOILS CONDITIONS

A. Understand existing soils conditions before submitting bid on work. No additional allowance will be granted due to lack of information for existing conditions of subsurface soils.

B. Submission of a bid will be considered acknowledgment of review/understanding of project geotechnical soils report.

# PART 2 - PRODUCTS

## 2.1 HAZARDOUS MATERIALS

A. Do not use products containing asbestos, lead, arsenic, or any other material defined by EPA as hazardous to human or animal life.

## 2.2 MATERIALS

A. Base contract upon furnishing materials as specified. Materials and equipment used for construction are to be new, the latest products as listed in manufacturer's printed catalog data and are to be UL or CSA approved or acceptable by state, county, and city authorities. Equipment supplier is responsible for obtaining state, county, and city acceptance on equipment not UL approved or not listed for installation.

B. Articles and equipment of a kind to be standard product of one manufacturer.

C. Names and manufacturer's names denote character and quality of equipment desired and are not to be construed as limiting competition.

# PART 3 - EXECUTION

## 3.1 ACCESSIBILITY AND INSTALLATION

A. Install equipment having components requiring access (i.e., drain pans, drains, fire dampers, control dampers, control operators, valves, motors, drives, and the like) so that they may be serviced, reset, replaced or recalibrated and the like, by service people with normal service tools and equipment. Notify Architect in writing if equipment or components are shown in such a position that above cannot be accomplished.

B. Install equipment complete as directed by manufacturer's installation instructions. Obtain installation instructions from manufacturer prior to rough-in of equipment, examine instructions thoroughly. When requirements of installation instructions conflict with Contract Documents, request clarification from Architect prior to proceeding with installation. This includes proper installation methods and sequencing, in coordination with other trades and disciplines.

C. Earthwork:
1. Refer to Division 31.
2. Perform excavation and backfill for installation of mechanical work.

D. Firestopping:
1. Coordinate with Drawings location of fire rated walls, ceilings, floors and the like. When these assemblies are penetrated, seal around piping, ductwork, equipment, and the like, with approved firestopping material.
2. Install firestopping material complete as directed by manufacturer's installation instructions. Meet requirements of ASTM E814.

## 3.2 SEISMIC CONTROL

A. Provide per Section 23 05 48, Vibration and Seismic Controls for HVAC Piping and Equipment.

## 3.3 REVIEW BY ENGINEER

A. Notify Architect/Engineer, in writing, at following stages of construction so that Architect/Engineer may, at their option, visit site for review and construction observation:
1. Underground piping installation prior to backfilling.
2. Prior to covering walls.
3. When ceiling installation is started.
4. When main systems, or portions of, are being tested and ready for inspection by AHJ.

5. When ductwork installation starts.
6. When installation starts for each different major type of equipment.
7. When lines or ducts are to be permanently concealed by construction or insulation systems.
8. When balancing and testing is started.

## 3.4 OPERATING DURING CHANGEOVER

A. During remodeling of existing structure, or addition of a structure to existing structure, while existing structure is occupied, present services to remain intact until new construction, facilities or equipment is installed.

B. Prior to changing over to new service, verify that every item is thoroughly prepared. Install new piping, wiring, and the like, to point of connection.

C. Perform actual transfer to new service at off-peak time, as coordinated with Owner. Once changeover is started, pursue it to its completion, to keep interference to a minimum.

## 3.5 MUTILATION

A. Repair mutilation of building around pipes, ducts, and the like.

## 3.6 DEMOLITION

A. Scope:
1. It is intent of these documents to provide necessary information and adjustments to mechanical system required to meet code, and accommodate installation of new work.
2. Coordinate with Owner so that work can be scheduled not to interrupt operations, normal activities, building access, access to different areas.
3. Existing Conditions: Determine exact location of existing utilities and equipment before commencing work, compensate Owner for damages caused by failure to exactly locate and preserve underground utilities. Replace damaged items with new material to match existing. Promptly notify Owner if utilities are found which are not shown on Drawings.

B. Equipment: Unless otherwise directed, equipment or fittings being removed as part of the demolition process are the Owner's property. Remove other items not scheduled to be reused or relocated from job site as directed by Owner.

C. Unless specifically indicated on the Drawings, remove exposed, unused piping to behind finished surfaces (floor, walls, ceilings, etc.). Cap piping and patch surfaces to match surrounding finish.

D. Unless specifically indicated on the Drawings, remove unused equipment, fittings, rough-ins, connectors, etc. Removal is to be to a point behind finished surfaces (floors, walls, ceilings, etc.).

## 3.7 ELECTRICAL INTERLOCKS

A. Where equipment motors are to be electrically interlocked with other equipment for simultaneous operation, utilize mechanical equipment wiring diagrams to coordinate with electrical systems so that proper wiring of equipment involved is affected.

## 3.8 EQUIPMENT SELECTION AND SERVICEABILITY

A. Replace or reposition equipment which is too large or located incorrectly to permit servicing, at no additional cost to Owner.

B. Maintain design intent where equipment other than as shown in Contract Documents is provided. Where equipment requires piping arrangement, control diagrams, or sequencing different from that indicated in Contract Documents, provide electrical motors, wiring, controls, or other required electrical components at no additional cost to Owner.

## 3.9 DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle materials and equipment in a manner to prevent damage and deterioration. Store in original container which identifies manufacturer's name, brand and model number. Do not store indoor equipment outdoors unless provided with a waterproof protective cover.

B. Replacement: In event of damage, immediately make repairs and replacements necessary.

## 3.10 DEMONSTRATION

A. Upon completion of work and adjustment of equipment, test systems to demonstrate to Owner's Representative and Architect that equipment furnished and installed or connected under provisions of these Specifications functions mechanically in manner required.

B. Manufacturer's Field Services: Furnish services of a qualified person for a period of not less than sixteen hours, at a time approved by Owner, to instruct maintenance personnel, correct defects or deficiencies, and demonstrate to satisfaction of Owner that entire system is operating in a satisfactory manner and complies with requirements of other trades or Contractors that may be required to complete work. Complete instruction and demonstration prior to final job site observations.

## 3.11 CLEANING

A. Upon completion of installation, thoroughly clean exposed portions of equipment, removing temporary labels and traces of foreign substances. Throughout work, remove construction debris and surplus materials accumulated by this work.

## 3.12 INSTALLATION

A. Install equipment in accordance with manufacturer's installation instructions, plumb and level, firmly anchored to vibration isolators. Maintain manufacturer's recommended clearances.

B. Start up equipment, in accordance with manufacturer's start-up instructions, and in presence of manufacturer's representative. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.
   1. Do not place equipment in sustained operation prior to initial balancing of mechanical systems.
   2. Furnish sufficient refrigerant and dry nitrogen for pressure testing under manufacturer's supervision.
   3. Provide and install additional fan sheaves to obtain design capacities. Coordinate exact requirements with balancing firm.

## 3.13 PAINTING

A. Ferrous Metal: After completion of mechanical work, thoroughly clean and paint exposed supports constructed of ferrous metal surfaces in mechanical rooms, i.e., hangers, hanger rods, equipment stands, and the like, with one coat of black asphalt varnish or black enamel suitable for hot surfaces.

B. Machinery:
1. In a mechanical room, on roof or other exposed areas, machinery and equipment not painted with enamel to receive two coats of primer and one coat of rustproof enamel, colors as selected by Architect.
2. See individual equipment Specifications for other painting.
3. Structural Steel: Repair damage to structural steel finishes or finishes of other materials damaged by cutting, welding or patching to match original.

C. Piping: Clean, primer coat and paint exposed piping on roof or at other exterior locations with two coats paint suitable for metallic surfaces and exterior exposures. Color selected by Architect.

## 3.14 CUTTING AND PATCHING

A. Refer to Section 01 73 29 "Cutting and Patching."

## 3.15 ACCEPTANCE

A. System can not be considered for acceptance until work is completed and demonstrated to Architect that installation is in strict compliance with Specifications, Drawings and manufacturer's installation instructions, particularly in reference to following:
1. Testing and balancing reports.
2. Cleaning.
3. System balancing and balancing logs.
4. Operating and Maintenance Manuals.
5. Training of operating personnel.
6. Record Drawings.
7. Guaranty certificates.
8. Start-up and test document.

## 3.16 LETTER OF CONFORMANCE

A. Provide letter and copies of extended warranties with a statement in letter that mechanical items were installed in accordance with manufacturer's recommendations. Include letter of conformance and warranties in operating and maintenance manuals.

B. Warranties to begin at date of substantial completion.

**END OF SECTION**

# SECTION 23 00 40

# ACCEPTANCE TESTING AND DOCUMENTATION

## PART 1 - GENERAL

### 1.1 SCOPE OF WORK

A. This section describes the Acceptance Testing and documentation of the mechanical system(s) and outlines the duties and responsibilities of the contracting team for Acceptance Testing.

B. Apply the Acceptance requirements to products, equipment and systems provided under this Division, where indicated on plans, and where required by California Title 24 requirements.

C. Engage the services of a firm specializing in commissioning of mechanical systems or shall submit contractor qualifications for review by architect where testing and documentation is to be performed by contractor. Where duct pressure testing validation is required, submit name and qualification for HERS Certified testing agency.

### 1.2 THE COMMISSIONING TEAM

A. Form the Commissioning Team of:
1. Mechanical contractor's representative
2. DDC Controls contractor's representative
3. HERS Certified Testing Agency where required
4. Inspector of record
5. Owner's staff representative

## PART 2 - PRODUCTS

### 2.1 DUTIES OF THE TEAM

A. The duties of the Team are as outlined in the Title 24 Requirements and summarized below:
1. Plan, organize and implement the Acceptance Testing process and within 1 month of the award of the contract, submit the names and addresses of the Testing team member(s).
2. The Acceptance testing team shall submit a complete description of the testing procedures and systems to be tested to the architect for review.
3. The Acceptance testing team shall coordinate tests of systems and equipment and assemble documentation related to tests. Submit documentation relative to tests and proposed procedures to design engineer for review prior to submitting documentation to Authority having Jurisdiction (AHJ.) Team responsible for performing data analysis, calculation of performance indices and crosschecking of results with the requirements of Title 24 and the Contract documents. The installing contractor or agent responsible for testing and documentation shall record their State of California Contractor's license number or their State of California Professional Registration License number on each Certificate of Acceptance for submittal.

4. Responsible for submitting Certificate of Acceptance including paper and electronic copies of measurements and monitoring results and supporting documentation to the AHJ. Where AHJ questions results or requires additional testing, complete additional testing and provide required documentation at no additional cost to the Owner.

## 2.2 TIME SCHEDULE

A. Determine the time period of the commissioning of the systems by the general contractor and Acceptance testing team. It is important to note that AHJ will not release a final Certificate of Occupancy until a Certificate of Acceptance is submitted that demonstrates that the specified systems and equipment have been shown to be performing in accordance with the Title 24 standards.

## 2.3 ACCEPTANCE TESTING – PHASE I - DOCUMENTATION

A. Team shall assemble documentation showing thermostat and sensor locations, control device locations, control sequences and notes.

B. Per Title 24 requirements, team shall provide record drawings to building owner within 90 days of receiving a final occupancy permit (refer to other specification sections for requirements on record drawings.)

C. Per Title 24 requirements, team shall provide operating and maintenance manuals to the building owner (refer to other specification sections for requirements on operation and maintenance manuals.)

## 2.4 ACCEPTANCE TESTING – PHASE II – INSPECTION AND TESTING

A. Team shall review the installation, perform acceptance testing and document results for the following systems:
1. Variable Air Volume Systems
2. Constant Volume Systems
3. Package Systems
4. Air Distribution Systems
5. Economizers
6. Ventilation Systems
7. Variable Frequency Drive Fan Systems
8. Hydronic Control Systems
9. System Programming

B. Review of installation shall confirm mechanical equipment and devices are properly located, identified, calibrated, and set points and schedules programmed per contract document requirements.

## 2.5 ACCEPTANCE TESTING - PHASE III - CERTIFICATION

A. Team shall document operating and maintenance information, complete installation certificate, and indicate test results on the Certificate of Acceptance, and submit the Certificate to the AHJ prior to receiving final occupancy permit. Team shall submit forms MECH-1-A through MECH-9-A as required by Title 24 requirements.

## PART 3 - EXECUTION

### 3.1 ACCEPTANCE TESTS AND DOCUMENTATION

A. Refer to California Title 24, Non-residential manual for specific testing procedures and documentation requirements. The detailed requirements can be found at http://www.energy.ca.gov/title 24/2005standards/index.html. Contractor is responsible for reviewing and complying with these standards

**END OF SECTION**

# SECTION 23 05 10

# HYDRONIC PIPING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Work Included:
   1. Materials, installation and testing of pipe, tubing and fittings.
   2. Refer to Specification Sections for each system medium (i.e., plumbing, hydronics, gas, and the like), for pipe application.

### 1.2 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer's Qualifications: Firms regularly engaged in manufacture of piping products of types and sizes required.
   2. Welding Qualification: Qualify welding procedures, welders and operators in accordance with ANSI B31.9 for shop and project site welding of piping work.

B. Manufacturer's Inspection: Inspect flanges, fittings and field applied welds in accordance with manufacturer's standard written quality control procedure in accordance with the following techniques:
   1. Visual Method: Comply with MSS SP-55 except as otherwise indicated.
   2. Radiographic (X-Ray) Method: Employ wherever recommended or required for pressurized piping systems.

### 1.3 SUBMITTALS

A. Piping Materials List: Provide a typewritten list which schedules the piping materials to be used for each system as a function of applicable nominal pipe size ranges. Arrange schedule in outline form for each specific piping system, e.g., "Chilled Water System," "Heating Water System," and the like. Include ASTM, ANSI or other numbers and other data as necessary to demonstrate compliance with requirements.

B. Test Procedure: Submit a typewritten checklist type of testing procedure indicating testing medium (i.e., water, air, nitrogen, and the like), pipe service, pipe and fitting type and classification, test pressure, pass/fail criteria and any other pertinent data.

## PART 2 - PRODUCTS

### 2.1 PIPING - GENERAL

A. Provide pipe, tube and fittings of the type, fitting requirements, grade, class, size and weight indicated or required for each service, as indicated in other Division 23 Specifications. Where type, grade, or class is not indicated, provide proper selection as determined by installer for installation requirements, and comply with governing regulations and industry standards.

## 2.2 STEEL PIPE

A. ASTM A53, Hot Dipped, Zinc Coated Welded or Seamless, Grade B: Black, unless otherwise indicated, schedule as specified.

B. ASTM A135, Electric Resistance Welded, Grade B: Black, unless otherwise indicated, schedule as specified.

## 2.3 COPPER TUBE

A. Temper: Annealed (hard drawn).

B. Water Service: ASTM B88, Type as indicated for each service.

C. Drain, Waste, and Vent (DWV): ASTM B306.

## 2.4 FITTINGS FOR STEEL PIPE

A. General: Flanges, fittings, unions and other products, mark in accordance with MSS SP-25.

B. Welding Fittings: Wrought carbon steel fittings, ASTM A234, ANSI B16.9, B16.28. Butt-welding type unless otherwise indicated to be socket welding type.

C. Branch Connections: From mains or headers 2-1/2 inches or larger, welded tees or forged welding outlets.

D. Welding Outlets: "Weldolets" or "Threadolets" equivalent to Bonney Forge. Use forged welding outlets wherever branch line is at least 1 nominal pipe size smaller than local main or header.

E. Threaded Fittings: ANSI B2.1, ASTM A47, 150 PSI rating, except where otherwise specified, prevailing codes or requirements or Specifications dictate use of 300 PSI rating. Fabricate from standard malleable iron with dimensions conforming to ANSI B16.3.
   1. Fitting requirements for galvanized steel piping systems to be the same as for black steel pipe except each to have galvanized coating.
   2. Fittings for waste, vent and drainage piping to be drainage pattern type.

F. Flanges: Carbon steel conforming to ASTM A105, ANSI B16.5, and factory forged in the USA. Flanges which have been machined, remade, painted, or are nondomestic origin are not acceptable. Provide raised or full face ends wherever indicated or required.

G. Unions: ANSI B16.39, ASTM A47, and be fabricated from malleable iron with bronze-to-iron ground joints rated at 150 percent design operating pressure. Threads: ANSI B2.1.

H. Fasteners: Semi-finished carbon steel bolts and hex nuts conforming to ASTM A307. Threads and Dimensions: ANSI B1.1 and B18.2.

I. Threaded Pipe Plugs: ANSI B16.14.

J. Thread Lubricant: RectorSeal No. 5 or Slic-tite Teflon Paste.

K. Mechanical Couplings (For Chilled Water Systems Only Not on Heating Hot Water Systems):
1. Manufacturers: Victaulic, Gruvlok, or approved.
2. Coupling Housings: Malleable iron ASTM A47 or ductile iron ASTM A536.
3. Coupling Housing Description: Grooved or rolled mechanical type, which engages grooved or rolled shouldered pipe ends, encasing an elastomeric gasket which bridges pipe ends to create seal. Cast in two or more parts, secured together during assembly with nuts and bolts. Permit degree of contraction and expansion as specified in manufacturer's published literature.
4. Gaskets: Mechanical grooved or rolled coupling design, pressure responsive so that internal pressure serves to increase seal's tightness, constructed of elastomers having properties as designated by ASTM D2000. Water Services: EDPM Grade E, with green color code identification.
5. Bolts and Nuts: Heat treated carbon steel, ASTM A183, minimum tensile 110,000 PSI.
6. Branch Stub-Ins: Upper housing with full locating collar for rigid positioning engaging machine-cut hole in pipe, encasing elastomeric gasket conforming to pipe outside diameter around hole, and lower housing with positioning lugs, secured together during assembly with nuts and bolts.
7. Fittings: Grooved or rolled shouldered end design to accept grooved or rolled mechanical couplings.
   a. Malleable Iron: ASTM A47.
   b. Ductile Iron: ASTM A536.
   c. Fabricated Steel: ASTM A53, Type F for 3/4 to 1-1/2 inches; Type E or S, Grade B for 2 to 20 inches.
   d. Steel: ASTM A234.
8. Flanges: Class 125 cast iron and Class 150 steel bolt hole alignment.
   a. Malleable Iron: ASTM A47.
   b. Ductile Iron: ASTM A536.
9. Pipe/Grooved: Carbon steel, A-53B/A-106B/A135 Schedule 40. Roll or cut grooved-ends as appropriate to pipe material, wall thickness, pressures, size and method of joining. Pipe ends to be grooved or rolled in accordance with current listed standards conforming to ANSI/AWWA C-606.

L. Pressfit System:
1. Manufacturers: Victaulic or approved.
2. Carbon steel Pressfit system for 2 inches and under Schedule 5, 0.065 wall pipe conforming to ASTM A235, A795 or A53, having a maximum yield strength of 45,000 PSI and a maximum hardness of Rb70. Water, air, chemical, oil and vacuum systems with working pressures to 300 PSI. UL/FM approved to 175 PSI.

## 2.5 FITTINGS FOR COPPER TUBE

A. Wrought copper/bronze solder joint fittings complying with ANSI B16.22.

B. DWV Service:
1. Cast Copper Solder Joint Drainage Fittings: ANSI B16.23.
2. Wrought Copper Solder Joint Drainage Fittings: ANSI B16.29.

C. Wrought or cast copper/bronze rolled joint fittings complying with ANSI B16.22.

## 2.6 MISCELLANEOUS PIPING MATERIALS/PRODUCTS

A. Insulating (Dielectric) Unions: Under no circumstances shall dielectric unions or dielectric pipe nipples be used on heating hot water, domestic and chilled water on piping applications, exterior and interior. To isolate ferrous from nonferrous piping, and prevent galvanic corrosion action, high-grade brass nipples and brass unions at transition points.

B. Welding Materials: Comply with Section 2-C of ASME Boiler Code, as applicable.

C. Tin-Antimony Soldering Materials: ASTM B13.

D. Gaskets for Flanged Joints: ANSI B16.12; full faced for cast iron flanges; raised face for steel flanges, unless otherwise indicated or recommended by manufacturer. Gaskets: Minimum 1/8-inch thick fabricated from nonasbestos bases.

E. Copper-Brazed: Make brazed joints for copper tubing and fittings with code approved brazing filler alloys meeting ASTM and AWS standards and listings. Filler alloys of BCuP2 classification (e.g., "Phos-O" or "Fos-Copper") may not be used to make joints between copper tubing and cast brass or bronze fittings. Filler alloys containing cadmium are not approved for use in potable water piping. Installations conform to accepted published procedures, i.e., UPC Installation Standard 3-75 and CDA Publications. Use of steel wool for cleaning tube and fittings is prohibited.

## 2.7 PREINSULATED PIPING SYSTEM

A. Manufacturers: Rovanco, Thermacore, PERMA-PIPE or approved.

B. Factory preinsulated piping system, consisting of an inner media carrier pipe, insulation around the carrier pipe, and a water/vapor seal jacket over the insulation.

C. Carrier Pipe Material: Schedule 40 black steel pipe with 150 PSI malleable screwed fittings. Type "K" copper with brazed fittings approved.

D. Insulation: Rigid closed cell polyurethane, average density of at least 2 lb./ft.3, conforming to ASTM C552, Type II, Class 1, K factor of not more than 0.14 (BTU/in)/(hr/sq.ft./deg. F) at 50F.

E. Outer Casing:
1. PVC pipe of minimum 60 mils thickness.
2. Each factory prefabricated section provides complete sealing of the insulation at each end of the conduit section by one of the methods listed below. Provide a permanent water and vapor seal.
3. Carry over the outer casing and extend it to the carrier pipe.
4. Use prefabricated caps specifically designed for end seal of prefabricated insulation systems. Fabricate caps of the same material as the outer casing.

## 2.8 UNIONS

A. Steel Pipe Union: 150 PSI malleable iron, brass to iron seat, ground joint, black or galvanized to match pipe.

B. Copper Pipe Union: 200 PSI working pressure. Bronze body, solder or grooved ends. Pipes 2 inches and under use ground joint, pipes 2-1/2 inches and larger use flanged face or grooved ends.

C. Insulating Unions: 250 PSI working pressure. Pipe ends and material to match piping. Electric current below 1 percent of galvanic current. Gasket material as recommended by manufacturer. Epco or approved.

## 2.9 ESCUTCHEONS

A. Brass material, chrome plated finish. Size sufficient to cover pipe openings through wall, floor or ceiling. Set screw or spring to secure to pipe. Coordinate opening sizes.

## 2.10 ACCESS PANELS

A. Manufacturers: Milcor, Karp, Elmdor, In-Ryko, Acudor, or approved. Provide two keys for each set of locks provided.

B. Provide flush mounting access panels as required for service of fire dampers, cleanouts, valves, and the like, and other items requiring maintenance or inspection. Where access panels are located in fire-rated assemblies of building, rate access panels accordingly. Ceiling access panels to be minimum 24x24 (or required and approved size). Wall access panels to be minimum 12x12 (or required and approved size).

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. General Electrical Equipment Clearances: Do not route piping through electrical rooms, transformer vaults, elevator equipment rooms, and other electrical or electronic equipment spaces and enclosures. Within equipment rooms, provide minimum 3 feet lateral clearance from sides of electric switchgear panels. Do not route piping above any electric power or lighting panel, switchgear, or similar electric device. Coordinate with electrical and coordinate exact pipe routing to provide proper clearance with such items.

B. Installation/Coordination:

1. General: Comply with basic requirements of Section 23 05 29, Hangers and Supports for HVAC Piping and Equipment. Install pipe, tube and fittings in accordance with recognized industry practices which will achieve permanently leakproof piping systems, capable of performing each indicated service without piping failure. Install each route with a minimum of joints and couplings, but with adequate and accessible unions or flanges for disassembly, maintenance, and replacement of valves and equipment. Reduce sizes by use of reducing fittings. Align piping accurately at connections, within 1/16-inch misalignment tolerance. Comply with ANSI B31.9 Code for Pressure Piping.
2. Installed piping not to interfere with maintenance of equipment, opening of doors or other moving parts nor be directly above or near any portion of electrical equipment.
3. Support piping such that connected equipment and flanges do not bear weight of piping.
4. Adequately support vertical lines at their bases or by a suitable hanger placed in horizontal line near the riser or, preferably, by a base fitting set on a pedestal.
5. Piping systems are to be installed to drain. Provide properly sized drain valves at low points.

6. Ream pipes after cutting to full bore. Remove foreign matter from inside of pipe before installing. Keep installed piping free from dirt and scale and protect open ends from foreign matter. Use temporary plugs or other approved methods for opening and closure.
7. Remake or replace defective, leaking or otherwise unsatisfactory joints or material. Peening, caulking, or doping of piping is not permitted.
8. Install piping to prevent stresses and strains to piping and hangers and supports due to expansion or contraction and building settlement. Provide proper loops, guides, offsets, anchor points, or expansion joints. Verify with anticipated settlement or shrinkage of building. Verify construction phasing of project, type of building construction products and type for coordinating installation of piping systems. Include provisions for servicing and removal of equipment without dismantling piping.
9. Piping Systems Routing Within Unconditioned Spaces, Plenums, Chases, or Cavities:
   a. Unless absolutely unavoidable, route fluid filled and (or) pressurized piping systems on the "warm" side of local building wall, roof, or ceiling thermal insulation batts, boards, or blankets as near to heated space as practical.
   b. Whenever such routing as described above is entirely impractical or impossible, provide heat tracing systems to piping, wherever necessary. Inform Architect before proceeding.
10. Corrosion Control: Underground Steel Piping Corrosion Protection: Factory wrap uninsulated underground steel piping systems with protective coating composed of a coal-tar saturated wrapping tape over a 20 mil thick coal-tar epoxy coating, equivalent to "Republic X-Tru-Coat." Wrap joints spirally with a minimum overlap of 1/2 tape width. Extend wrap not less than 3 inches above grade. . Provide tinker test to check for holidays. Provide cathodic protection to meet requirements of NACE Standard RP0169-2002.
11. Pipe Sleeves:
   a. Lay out work in advance of pouring concrete and furnish and set sleeves necessary to complete work.
   b. Floor Sleeves and Exterior Wall Sleeves: Provide sleeves on pipes passing through concrete or masonry construction. Extend sleeve 1 inch above finished floor. Caulk pipes passing through floor with nonshrinking grout or approved caulking compound. Provide "Link-Seal" Type S sleeve sealing system for slab on grade and exterior walls. Caulk/seal piping and ductwork passing through fire rated building assembly with UL rated assemblies. Provide fire-rated assemblies per local AHJ requirements.
   c. Wall Sleeves: Provide sleeves on pipes passing through concrete or masonry construction. Provide sleeve flush with finished face of wall. Caulk pipes passing through walls with nonshrinking caulking compound. Caulk/seal piping and ducts passing through fire-rated building assemblies with UL approved fire-rated assemblies. Provide fire-rated assemblies per local AHJ requirements.
12. Conform with applicable codes and industry standards.
13. Install uninsulated piping so that unrestrained direct contact with the structure or other system installations is avoided. Where contact with or passage through building or structural features cannot be avoided; firmly anchor piping to, or isolated from, the structure to prevent noise transmission and occurrence of physical damage. Install piping to be insulated with adequate clearance around piping to allow for placement of full thickness insulating material.

C. Pressure Piping Routing:
1. Route piping, except as otherwise indicated, vertically and horizontally (sloped to drain). Avoid diagonal runs wherever possible. Orient horizontal routes parallel with walls and beam lines.

2. Install piping as shown or described by diagrams, details and notations on Drawings or, if not indicated, install piping to provide the shortest route which does not obstruct usable space or block access for servicing the building and its equipment.
3. Support piping adjacent to walls, overhead construction, columns and other structural and permanent enclosure elements of the building. Limit clearance to 1/2 inch wherever furring is indicated for concealment of piping. Allow for insulation thickness, if any. Locate insulated piping to provide minimum 1-inch clearance outside insulation.
4. Wherever possible in finished and occupied spaces, conceal piping from view by locating within column or beam enclosures, hollow wall construction, or above suspended ceilings. Do not encase horizontal routes in solid partitions, except where approved.

D. Preparation:
1. Unions:
   a. Insulating (Dielectric) Unions: Comply with manufacturer's instructions for installing unions wherever piping of dissimilar metals are adjoined. Install unions in manner which will prevent galvanic action and inhibit corrosion.
   b. Standard Unions: Install where indicated on Drawings and on each side of pieces of equipment to permit easy removal of equipment.
2. Copper Tubing:
   a. Remove burrs from and clean outer surface of tube ends and inner surface of fittings.
   b. Copper-Soldered: Make soldered joints for copper tubing and fittings with code approved solder alloys meeting ASTM and ANSI standards and listings. Solder-paste-flux combination fillers are not approved. Installations to conform to accepted published procedures, i.e., UPC IS 375, IS 21-80 standards and CDA Publications. Use of steel wool for cleaning tube and fittings is prohibited. Apply flux as recommended by manufacturer. Allstate Silver Bearing Solder 430 or other approved solder alloys which do not contain lead or cadmium.
   c. Copper-Brazed: Make brazed joints for copper tubing and fittings with code approved brazing filler alloys meeting ASTM and AWS standards and listings. Filler alloys of BCuP2 classification (e.g., "Phos-0" or "Fos-Copper") may not be used to make joints between copper tubing and cast brass or bronze fittings. Filler alloys containing cadmium are not approved for use in potable water piping. Installations to conform to accepted published procedures, i.e., UPC IS 3-75 standards and CDA Publications. Use of steel wool for cleaning tube and fittings is prohibited. Remove bonnets and nonmetallic seats on valves and cool body with damp cloth while soldering or brazing. Remove excess flux from completed joints in accordance with manufacturer's instructions and code standards.
   d. Copper-Rolled Joints: Pipe ends clean and free from indentations, projections and roll marks in the area from pipe end to rolled area for proper sealing of gasket. Apply a thin uniform coat of nonpetroleum-based lubricant to the gasket, coupling or housing by brush or hand. Place the gasket over one pipe end, the pipe ends aligned and brought together, and the gasket positioned between rolled area and pipe ends. Assemble the coupling housing over the gasket with housing keys engaging both rolled areas. Insert the bolts and nuts started, uniformly tighten until the housing bolt pads are firmly together, metal to metal.
   e. Pressurized Service:
      1) Unless otherwise indicated, wrought copper/bronze solder joint fittings complying with ANSI B16.22.1995.

2) Copper Tube Unions: Standard products as recommended by manufacturer for use in the service. Rated at 150 percent design operating pressure.

3) Mechanically Formed Tee Connections:
   a) Form mechanically extracted collars in a continuous operation consisting of drilling a pilot hole and drawing out the tube surface to form a collar having a height of not less than three times the thickness of the tube wall. Fully adjustable collaring device to ensure roper tolerance and complete uniformity of the joint.
   b) Notch the branch to conform with the inner curve of the run tube and dimpled to ensure penetration of the branch tube into the collar is of sufficient depth for brazing and that the branch tube does not obstruct the flow in the main line tube.
   c) Braze joints in accordance with the Copper Development Association Copper Tube Handbook using B-cup series filler metal. Note: Soft soldered joints will not be permitted.

## 3.2 FIELD QUALITY CONTROL

A. Inspection:
   1. Upon completion of installation of plumbing fixtures and after units are water pressurized, test fixtures to demonstrate capability and compliance with requirements. When possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units and proceed with retesting.
   2. Inspect each installed unit for damage to finish. If feasible, restore and match finish to original at site; otherwise, remove fixture and replace with new unit. Feasibility and match to be judged by Architect. Remove cracked or dented units and replace with new units.

## 3.3 ADJUSTING AND CLEANING

A. General: Clean exterior surfaces of installed piping systems of superfluous materials, and prepare for application of painting, insulation, or coatings, if any. Comply with the preparation requirements of Section 23 05 53, Identification for HVAC Piping and Equipment, and Section 23 07 00, HVAC Insulation, as applicable. Flush out water filled or drainage piping systems with clean water, and flush other piping systems with dry air or nitrogen after completing required tests. Inspect each segment of each system for completion of joints, supports, and accessory items.

B. Inspection: Inspect pressurized piping in accordance with the procedures of ANSI B31.9.

## 3.4 PROTECTION

A. Protect piping from damage. Replace damaged items with new.

## 3.5 ESCUTCHEONS

A. Install on exposed pipes passing through walls or floors.

## 3.6 PIPE TEST

A. General:
   1. Make tests in presence of Architect or authorized representative.

2. Make test before pipes are concealed.
3. Fill system and remove air from system at least 24 hours before test begins.
4. Correct leaks in screwed fittings by remaking the joint. Cut out leaks in welded joints and reweld; caulking is not permitted.

B. Water piping: Apply test pressure of 125 PSI and maintain for 1 hour with no visible leaks and no appreciable drop after the test pump has been disconnected.

## 3.7 ACCESS PANELS

A. Install wall and ceiling access panels to provide access to concealed valves, fans, motors, shock arrestors, fire dampers, terminal units, coils and other mechanical items needing service. Provide access panels at locations required or specified herein. Coordinate locations/sizes of access panels with Architect prior to work.

**END OF SECTION**

# SECTION 23 05 13

# COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Work Included: Materials, installation and testing of motors and starters.

B. Refer to Specification sections for each system medium (i.e., hydronics, gas, and the like), for motor/starter application.

### 1.2 QUALITY ASSURANCE

A. Motor Manufacturers:
1. General Electric, Westinghouse, U.S. Motors, Wagner, Century/Gould, Louis-Allis, Reliance, Marathon, or approved.
2. Standards: ANSI/IEEE 112 and NEMA MG-1.

B. Starter Manufacturers:
1. Allen Bradley, Square D, General Electric, Siemens, Furnas, Eaton Electrical, or approved.
2. Manufacturer is certified ISO 9002 facility 3, UL listed.

### 1.3 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data, motor efficiency, installation instructions, and dimensioned drawings for each type of motor or starter.

B. Maintenance Data: Submit maintenance data and parts list for each type. Include this data, product data, and certifications in maintenance manual.

## PART 2 - PRODUCTS

### 2.1 ELECTRIC MOTORS

A. Motors: Energy efficient, suitable for nonoverloading operation, and capable of continuous operation at full nameplate rating. Motors 1 HP and larger must meet Energy Policy act of 1992. Motors to be high efficient type similar to Century/Gould E-plus.

B. Take NEMA standards as minimum requirements for motor design and performance. Motors suitable for load, duty, voltage, frequency, hazard and for service and location intended. Motors, unless specified otherwise, to be general purpose open dripproof type, ball bearing equipped, 40C temperature rise; and rated for continuous duty under full load. Motors to have name plate giving manufacturer's name, shop number, HP, RPM and current characteristics.

C. Motors smaller than 1/2 horsepower, 1 phase; and motors 1/2 horsepower and larger, 3 phase and voltage as indicated on Drawings. Maximum motor speed of 1750 RPM, unless otherwise noted. One phase motors to have internal thermal overload protection with automatic reset.

D. Motors for belt drive to have adjustable bases with set screw to maintain belt tension. Motor horsepowers indicated on the Equipment Schedule on Drawings are the minimum size acceptable.

E. Provide two-speed motors where indicated on schedule or in sequence.

F. Provide inverter rated motors per NEMA MG1-31 where variable frequency drives are applied or soft start starters.

## 2.2 STARTERS

A. Single Phase Motors:
1. Manual across-the-line starting switch having toggle-operated switch pilot running light and built-in thermal overload device with heating element rated not more than 115 percent motor full load current indicated on name plate of motor to be protected. Surface mount starters. Provide NEMA-1 enclosure.
2. Overload relays to be melting alloy type with a replaceable control circuit module. Thermal units to be interchangeable. Starter to be nonoperative if thermal unit is removed.
3. Single phase motors with automatic controls. Provide motor rated relay with coils rated for control voltage.

B. Starters up to size 8 to be suitable for the addition of a minimum of three external auxiliary contacts (normally open or normally closed). Contactor, coils, and relays to perform the control functions of the associated equipment and control sequence.

C. Three phase motors up to and including 15 HP:
1. Provide enclosed type magnetic across-the-line starter with thermal overload and under voltage protection.
2. Operator: "Start-Stop" pushbutton, except where automatic control is indicated on Drawings or specified. Then provide "Hand-Off-Auto" selector switch.
3. Starters for 3 phase motors to have overload protection in each of the three legs, with external manual reset.
4. Unless indicated on Drawings or in Specifications, furnish motor starters with a neon pilot light. Neon lights are required for all exhaust fan switches.
5. Equip starters with integral transformer and coil for control circuit. Coordinate coil voltage with control voltage.

D. For 3 phase motors greater than 15 HP:
1. Provide combination starter and fused safety disconnect integral in the same enclosure. Utilize Type 'RK' or 'L' fuses. Provide fuse block with rejection type fuse holders. Size fuses per motor manufacturer's recommendations.
2. Provide a solid-state reduced voltage starter, consisting of power section, one-piece removable printed circuit logic board and field wiring interface terminals. Logic board uses quick disconnect plug-in connectors for current transformers inputs, line-and-load voltage inputs, SCR gate firing output circuits and status panel. Three phase current sensing via current transformers. Class 10 electronic overload protection.
3. Motor starters to include the following protections:
   a. Inverse time running overcurrent protection.
   b. 250 percent to 500 percent current limit adjustment
   c. Minimum and maximum voltage adjustments.
   d. Voltage stability adjustment.
   e. Single-phase protection with built-in short-time delay.
   f. Undervoltage protection with built-in short time delay.

g. MOV surge suppression protection of SCRs rated 10 percent above the rated voltage.
h. Phase sequence protection.

4. Display: Door-mounted status LCD alphanumeric or LED display indicating run, undervoltage, phase loss, phase current unbalance, overcurrent trip, overtemperature, current limit, end of ramp, and incorrect phase rotation.
5. Enclosure: NEMA 12. Operator: "Start-Stop" pushbutton, except where automatic control is required, then provide "Hand-Off-Auto" selector switch
6. Input/Output Relays: Provide relays as required to provide the control sequence.
7. UL 508 listed.

E. Motor starters for equipment not installed in Division 26, Section 26 24 19 "Motor Control" to be furnished and installed by Division 23.

F. Shaft Grounding:
1. Provide shaft grounding assembly on all motors controlled by variable frequency drive. Shaft grounding device to be in the form of brush that resides on the motor shaft. Brush assembly shall be capable of tolerating misalignment and maintaining rotating contact throughout the motor's life.
2. Material: Material used in the grounding assembly shall be stable material commonly used within industry that is not believed to constitute a hazardous material under Office of Safety and Health Act (OSHA regulations.
3. Brushes: Specifically developed carbon compounds of sustained performance with sear life expectancy of 3 years minimum.
4. Seals: In wet or severe environment applications, brush contact area shall be sealed type to keep contaminants from entering the shaft grounding system.
5. For clean room air handling systems, the shaft grounding assembly shall be of the type that contains the wear products within a special enclosure within the shaft grounding system.
6. Shaft grounding assembly installation shall not affect the motor manufacturer warranty. Where the severe environment conditions require application of the shaft grounding types that are screwed into the motor shaft, the installation of the shaft grounding system shall be performed either by the motor manufacturer or by the motor manufacturer authorized facility.
7. Manufacturer: Shaft Grounding Inc. or approved.
8. Bond the brush to the closest ground point using code sized green insulated stranded copper conductor per manufacturer instructions.
9. Test and verify the performance of the assembly to ensure that under no conditions the shaft exceeds 3 volts.

## 2.3 DISCONNECTS

A. Provided by Division 26 unless otherwise specified.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. Install a soft start per the manufacturer's specifications with a minimum clearance of 4 inches on each side of the enclosure.

B. Include a standard wiring diagram for making the appropriate electrical connections.

## 3.2 START UP

A. For soft starters provide the services of a qualified technician to program, test, and start up soft starts furnished under this Specification.

**END OF SECTION**

# SECTION 23 05 23

# GENERAL-DUTY VALVES FOR HVAC PIPING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Work Included: Materials, installation and testing of valves, including the following:
   1. Globe valves.
   2. Drain valves.
   3. Ball valves.
   4. Balancing valves.
   5. Butterfly valves.

B. Refer to Specification sections for each system medium (i.e., hydronics and the like), for valve application.

### 1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of valves of types and sizes required.

### 1.3 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data, installation instructions, and dimensioned drawings for each type of valve.

B. Maintenance Data: Submit maintenance data and parts list for each type valve. Include this data, product data, and certifications in maintenance manual.

## PART 2 - PRODUCTS

### 2.1 VALVES - GENERAL

A. General:
   1. Sizes: Unless otherwise indicated, provide valves of same size as upstream pipe size.
   2. Operators: Provide handwheels, fastened to valve stem, for valves other than quarter-turn. Provide lever handle for quarter-turn valves 6 inches and smaller, and four inches and smaller for plug valves. Provide gear operators for quarter-turn valves eight inches and larger. Provide chain-operated sheaves and chains for overhead valves.
   3. End Connections: Mate with pipe, tube and equipment connections. Where more than one type is indicated, selection is installer's option.

B. Service:
   1. Water Shutoff and Isolation Valves:
      a. Pipe Sizes 2-1/2 Inches and Smaller: Ball valve.
      b. Pipe Sizes 3 Inches and Larger: Butterfly valve.
   2. Drain Service; All Pipe Sizes: Drain valves.

C. Manufacturers: Crane, Fairbanks, Anvil, Jenkins, Kennedy, Walworth, Red/White (commercial grade), Mueller, Legend, Conbraco, Nibco, DeZurik, Hays, Powell, Stockham, Hammond, Watts, Milwaukee, Victaulic, or approved. Note: See individual sections for specialty valves (balancing valves, pressure regulators, relief valves, earthquake valves, gas valves).

## 2.2 GLOBE VALVES

A. 2 Inches and Smaller: Class 125, bronze body, screw-in bonnet, integral seat, renewable disc, straight body, Nibco 211. Angle body, Nibco 311.

B. 2-1/2 Inches and Larger: Class 125, iron body, bolted bonnet, flanged ends, renewable seat and disc, bronze mounted. Straight Body: Nibco F-718-B. Angle Body: Nibco F-818-B.

## 2.3 DRAIN VALVES

A. Class 125, bronze body, screw-in bonnet, rising stem, composition disc, 3/4-inch hose outlet. Threaded: Nibco 73. Solder: Nibco 72.

## 2.4 BALANCING VALVES

A. Bronze with a machined orifice flow restriction, multi-turn globe type valve, internal O-rings, rated working pressure of at least 240 PSIG (175 PSI iron construction, 2-1/2 inches and larger), flow setting indicating pointer and calibrated nameplate, memory stops, and pressure readout port with integral check valve on each side of the orifice. Bell & Gossett, Armstrong, Nibco, Wheatley, Tour & Anderson, or Illinois.

B. Combination check valve/balancing valve not allowed, 1/4 turn plug type allowed on 8 inches and larger pipe only.

## 2.5 BALL VALVES

A. 2-1/2 Inches and Smaller: 150 PSI, bronze body, full port, bronze trim, three-piece construction, TFE seats and seals. Threaded: Nibco T-595-Y. Soldered: Nibco S-595-Y.

B. 3 Inches and Larger: 150 PSI, cast iron body, full port, two-piece body, TFE seats with stainless steel ball. FDA rated for potable water. Flanged Connection: Watts G4000.

C. Victaulic Series 721 Standard Port Ball Valve: 2- to 4-inch ductile iron, ASTM A536, micro finish steel chrome plated or stainless steel ball and stem. TFE seats, 600 PSI.

## 2.6 BUTTERFLY VALVES

A. Select lug type valves.

B. 6 Inches and Smaller: 200 PSI, ductile iron body, extended neck, aluminum bronze disc, reinforced resilient EDPM seat, manual lever and lock. Nibco LD2000, or Victaulic 300 for mechanical coupling fittings.

## 2.7 ACCESS PANELS

A. Provide flush mounting access panels as required for service of fire dampers, cleanouts, valves, and the like, and other items requiring maintenance or inspection. Where access panels are located in fire-rated assemblies of building, rate access panels accordingly. Ceiling access panels to be minimum 24x24 (or required and approved size). Wall access panels to be minimum 12x12 (or required and approved size).

B. Manufacturers: Milcor, Karp, Elmdor, In-Ryko, Acudor, or approved. Provide two keys for each set of locks provided.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. Install valves where required for proper operation of piping and equipment, including valves in branch lines where necessary to isolate sections of piping. Locate valves so as to be accessible and so that separate support can be provided when necessary.

B. Install valves with stems pointed up, in vertical position where possible, but in no case with stems pointed downward from horizontal plane unless unavoidable. Install valve drains with hose end adapter for each valve that must be installed with stem below horizontal plane.

C. Insulation: Where insulation is indicated, install extended stem valves, arranged in proper manner to receive insulation.

D. Mechanical Actuators: Install with chain operators where indicated. Extend chains to 5 feet above floor and hook to clips to clear aisle passage.

E. Stem Selection: Outside screw and yoke stems, except provide inside screw, nonrising stem where space prevents full opening of OS&Y valves.

F. Seats: Renewable seats, except where otherwise indicated.

G. Balancing Valves: Install with minimum 4 pipe diameters, straight inlet and outlet pipe or per manufacturer's recommendations.

## 3.2 VALVE ADJUSTING AND CLEANING

A. Inspect valves for leaks. Adjust or replace packing to stop leaks. Replace valve if leak persists.

B. Valve Identification. Tag valves per "Identification for HVAC Piping and Equipment."

## 3.3 ACCESS PANELS

A. Install wall and ceiling access panels to provide access to concealed valves, fans, motors, shock arrestors, fire dampers, terminal units, coils and other mechanical items needing service. Provide access panels at locations required or specified herein. Coordinate locations/sizes of access panels with Architect prior to work.

**END OF SECTION**

# SECTION 23 05 29

# HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Work Included: Material and installation of supports, anchors and sleeves including: horizontal piping hangers and supports; vertical piping clamps; hanger rod attachments; building attachments; saddles and shields; miscellaneous metals, miscellaneous materials; roof equipment supports; anchors; equipment supports; wall and floor sleeves; and escutcheon plates.

### 1.2 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in the manufacture of supports and anchors, of types and sizes required.

B. Regulatory Requirements:
1. Provide pipe hangers and supports whose materials, design and manufacture comply with MSS SP-58, "Pipe Hangers and Supports - Materials, Design and Manufacture," latest edition.
2. Select and apply pipe hangers and supports complying with MSS SP-69, "Pipe Hangers and Supports - Selection and Application," latest edition.
3. A copy of the above-referenced standards on the construction site at all times.

C. Seismic: Provide per Section 23 05 48, Vibration and Seismic Controls for HVAC Piping and Equipment.

D. Manufacturers: B-Line, Elcen Metal Products Co., F&S Control, Globe, Kindorf, Kinline, Michigan, Superstrut, Unistrut, Power-Strut. Note: See individual Sections for roof equipment support.

### 1.3 SUBMITTALS

A. Submit the following:
1. Manufacturer's technical product data, including installation instructions, for each type of support, anchor and sleeve. Include UL approval drawing from manufacturer for each different pre-engineered firestop assembly.
2. Assembly type shop drawings for each type of sleeve, indicating dimensions, weights, required clearances, and methods of assembly of components.
3. Shop drawings for each individual roof pipe curb assembly, indicating number and location of each pipe or conduit which is to pass through the curb. Indicate pipe insulation requirements.

## PART 2 - PRODUCTS

### 2.1 PIPING HANGERS AND SUPPORTS

A. General:

1. Horizontal Piping Hangers and Supports-Horizontal and Vertical Piping, and Hanger Rod Attachments: Factory fabricated horizontal piping hangers and supports complying with MSS SP-58, to suit piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hangers and supports to exactly fit pipe size for bare piping, and to exactly fit around piping insulation with saddle or shield for insulated piping. Provide copper-plated hangers and supports for uninsulated copper piping systems.
2. Building Attachments: Factory fabricated attachments complying with MSS SP-58, selected to suit building substructure conditions, in accordance with MSS SP-69 and manufacturer's published product information. Select size of building attachments to suit hanger rods.
3. Saddles and Shields: Factory fabricated saddles or shields under piping hangers and supports for insulated piping. Size saddles and shields for exact fit to mate with pipe insulation. 1/2 round, 18 gauge, minimum 12 inches in length (4-inch pipe and larger to be three times longer than pipe diameter).
4. Roller Hangers: Adjustable roller hanger. Black steel yoke, cast iron roller.
5. Concrete Inserts: Malleable iron body, black finish. Lateral adjustment.
6. Continuous Concrete Insert: Steel construction, minimum 12 gauge. Electrogalvanized finish. Pipe clamps and insert nuts to match.

B. Pipe Hangers Size 2 Inches and Smaller: Adjustable swivel ring hanger, UL listed. Michigan 100 or 101.

C. Pipe Hangers Size 2-1/2 Inches and Larger: Adjustable clevis type, UL listed. Michigan 400.

D. Riser Clamps: Steel, UL listed. Michigan 510 or 511. Copper coated; Michigan 368.

E. Plumbers Tape: Not permitted as pipe hangers or pipe straps.

F. Michigan numbers are indicated for type and quality. Comparable products manufactured by Globe, Elcen, B-Line, Kindorf, Kinline, Unistrut, Anvil, Super Strut, Tolco, PHD, Power-Strut, or approved.

### 2.2 ROOF EQUIPMENT SUPPORTS

A. General:

1. Coordinate the location and type of each roof equipment support with the roofing system supplier. Coordinate systems to maintain roof warranty.
2. Minimum 18 gauge galvanized steel with fully mitered and welded corners, internal bulkhead reinforcing, integral base plates, pressure-treated wood nailer, and 18 gauge galvanized steel counterflashing. Provide insulated curbs where surrounding roof is insulated.
3. Compensate for slope in roof so top of support is level.
4. Construct curb to withstand seismic forces.

B. Manufacturers:

1. Equipment Supports: Pate ES, Custom Curb, Vibrex, or Thycurb.
2. Equipment Curbs: Pate PC, Custom Curb, Vibrex, or Thycurb.

3. Pipe Curb Assemblies: Pate PCC, Custom Curb, Vibrex, or Thycurb.

## 2.3 WALL AND FLOOR SLEEVES

A. General:
1. "Link-Seal" Pipe Sleeves: Neoprene gasket links bolted together around an interior sleeve forming a watertight seal. Provide Type S unless otherwise noted. Thunderline Corporation, or approved.
2. Pre-Engineered Firestop Pipe Penetration Systems: UL listed assemblies for maintaining fire rating of piping penetrations through fire-rated assemblies. Comply with ASTM E814.
3. Insulating Caulking: Eagle, Pitcher Super 66 high temperature cement, or approved.
4. Fabricated Accessories:
   a. Steel Pipe Sleeves: Fabricate from Schedule 40 black or galvanized steel pipe. Remove end burrs by grinding.
   b. Sheet Metal Pipe Sleeves: Fabricate from G-90 galvanized sheets closed with lock-seam joints. Provide the following minimum gauges for the sizes indicated:
      1) Sleeve Size four Inches in Diameter and Smaller: 18 gauge.
      2) Sleeve Sizes five to six Inches: 16 gauge.
      3) Sleeve Sizes seven Inches and Larger: 14 gauge.
   c. Fire-Rated Safing Material:
      1) Rockwool Insulation: Complying with FS-HH-I-558, Form A, Class IV, six lbs./cu.ft. density with melting point of 1985F and K value of 0.24 at 75F.
      2) Calcium Silicate Insulation: Noncombustible, complying with FS-HH-I-523, Type II, suitable for 100F to 1200F service with K value of 0.40 at 150F.

## 2.4 ANCHORS

A. General: Anchor supports to existing masonry, block and tile walls per anchoring system manufacturer's recommendations or as modified by project structural engineer.

B. Manufacturers: Anchor-It, Hilti Hit System, Epcon System, or Power Fast System.

# PART 3 - EXECUTION

## 3.1 PREPARATION

A. Examine the Drawings and coordinate for verification of exact locations of fire and smoke rated walls, partitions, floors and other assemblies. Indicate, by shading and labeling on Record Drawings such locations and label as "1-Hour Wall," "2-Hour Fire/Smoke Barrier," and the like. Determine proper locations for piping penetrations. Set sleeves in place in new floors, walls or roofs prior to concrete pour or grouting.

B. Install hangers, supports, anchors and sleeves after required building structural work has been completed in areas where the work is to be installed. Coordinate proper placement of inserts, anchors and other building structural attachments.

## 3.2 INSTALLATION

A. Building Attachments: Install within concrete or on structural steel or wood. Install additional building attachments where support is required for additional concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert secure to forms. Where concrete with compressive strength less than 2500 PSI is indicated, install reinforcing bars through openings at top in inserts.

B. Hangers and Supports:
1. Group parallel runs of horizontal piping to be supported together on trapeze-type hangers. Maximum spacings: MSS SP-69. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not support piping from other piping.
2. Support fire protection piping independently of other piping.
3. Prevent electrolysis in support of copper tubing by use of hangers and supports which are copper plated.
4. Allow controlled movement of piping systems to permit freedom of movement between pipe anchors and to facilitate action of expansion joints, expansion loops, expansion bends and similar units.
5. Piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
6. Insulated Piping: Provide protection saddles where insulation without vapor barrier is indicated. Provide protection shields on insulated piping where insulation with a vapor barrier is indicated.
7. Hanger Spacing:
   a. Steel Pipe 1 Inch and Smaller: 6 feet.
   b. Steel Pipe 1-1/4 Inches and Larger: 10 feet.
   c. Copper Tubing 1-1/2 Inches and Smaller: 6 feet.
   d. Copper Tubing 2 Inches and Larger: 10 feet.
   e. 90 Degree Offsets: Within 2 feet, both sides of offset.

C. Anchors: Install at ends of principal pipe runs where indicated on Drawings. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.

D. Roof Equipment Supports, Equipment Curbs, and Pipe Curb Assemblies:
1. Provide prefabricated units for roof membrane and insulation penetrations related to mechanical equipment. Coordinate with roofing system. Set supports on the structural deck. Do not set supports on insulation or roofing. Provide level supports by prefabricated pitch built into the curb.
2. Equipment Supports: Provide for roof mounted equipment which does not require a structural roof deck penetration (i.e., condensing units).
3. Equipment Curbs: Provide for equipment which requires a structural roof deck penetration other than piping or conduit (i.e., fans, ducts).
4. Pipe Curb Assemblies: Provide for piping and electrical conduit which penetrates the structural roof deck to service equipment above the roof level (i.e., refrigerant piping, electrical power and control wiring).
5. Piping above roof to be supported with freestanding roof pipe supports unless detailed otherwise.

E. Escutcheon Plates: Install around horizontal and vertical piping at visible penetrations through walls, partitions, floors, or ceilings, including penetrations through closets, through below ceiling corridor walls, and through equipment room walls and floors.

F. "Link-Seal" Pipe Sleeves: Install at exterior wall piping penetrations. For penetrations below grade provide Schedule 40 steel sleeve with 1-inch, continuously welded, "weep ring" centered on length of sleeve.

G. Fabricated Pipe Sleeves:
1. Provide either steel or sheet metal pipe sleeves accurately centered around pipe routes. Size such that piping and insulation, if any, will have free movement within the sleeve, including allowance for thermal expansion. Sleeves not to be more than 1 pipe size larger than piping or piping plus insulation size.
2. Length: Equal to thickness of construction penetrated, except extend floor sleeves 1/4 inch above floor finish and, where floor surface drains to a floor drain, extend floor sleeve 3/4 inch above floor finish.
3. Provide temporary support of sleeves during placement in concrete and other work around sleeves. Provide temporary end closures to prevent concrete and other materials from entering pipe sleeves.
4. Seal each end airtight with a resilient nonhardening sealer.

H. Installation of metallic or plastic piping penetrations through non fire-rated walls and partitions and through smoke-rated walls and partitions:
1. Install fabricated pipe sleeve.
2. After installation of sleeve and piping, tightly pack entire annular void between piping or piping insulation and sleeve I.D. with specified material.

I. Piping penetrations through fire-rated (1 to 3 hour) assemblies: Select and install pre-engineered pipe penetration system in accordance with the UL listing and manufacturer's recommendation.

## 3.3 ADJUSTING AND PAINTING

A. Adjust hangers so as to distribute loads equally on attachments. Provide grout under supports to bring piping and equipment to proper level and elevations.

B. Prime paint ferrous nongalvanized hangers, accessories, and supplementary steel which are not factory painted.

## 3.4 FIRESTOPPING PENETRATIONS IN FIRE-RATED WALL/FLOOR ASSEMBLIES

A. Refer to Section 07 84 00.

B. Provide proper sizing when providing sleeves or core-drilled holes to accommodate the penetration. Firestop voids between sleeve or core-drilled hole and pipe passing through to meet the requirements of ASTM E814.

C. Manufacturers: Hilti, Proset, or approved.

**END OF SECTION**

# SECTION 23 05 48

# VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Work Included: Materials and installation of seismic restraint devices and related items. Provide complete vibration isolation systems in proper working order.

### 1.2 CERTIFICATION DATA

A. Bidders on the air handling devices, fans and terminal units must supply the appropriate inlet, outlet, radiated, discharge, and loss or regenerated octave band sound power level data, measure in accordance with the applicable ASHRAE or ANSI Specifications at a certified laboratory. The units selected should meet the Specification criteria of the tables in this Section and Equipment Schedules on Drawings. Do not consider units in excess of the listed values as appropriate for use on this project.

### 1.3 SEISMIC CONTROL AND RESTRAINT

A. Mechanical Equipment:
   1. Brace or anchor mechanical equipment to resist a horizontal force acting in any direction using CBC, latest edition.
   2. Vibration Isolated Equipment: Provide factory fabricated seismic restrained vibration isolating components. Earthquake resistant designs for equipment, i.e., air handling units, blowers, motors, ductwork, and mechanical piping, to conform to the regulations of the CBC, latest edition. Where standard factory fabricated components are not available, provide properly designed custom components which meet the requirements herein.
   3. Provide any restraints noted on Drawings for Division 23 work.

B. Anchorage:
   1. Where anchorage details are not shown on Drawings, the field installation subject to approval of the project structural engineer.
   2. In other cases, retain a professional structural engineer licensed in the state in which the work will be done to provide shop drawings of seismic bracing for ductwork/equipment. Professional engineer to design and provide wet stamped (sealed) shop drawings for equipment, ductwork, and piping seismic bracing. Submit shop drawings and calculations along with equipment submittals.
   3. The restraints which are used to prevent disruption of the function of the piece of equipment because of the application of the horizontal force to be such that the forces are carried to the frame of the structure in such a way that the frame will not be deflected when the apparatus is attached to a mounting base and equipment pad, or to the structure in the normal way, utilizing the attachments provided. Secure equipment to withstand a force in any direction.

C. Specify the seismic bracing and anchorage of piping in Section "Hangers and Supports for HVAC Piping and Equipment."

D. Provide earthquake bumpers to prevent excessive motion during starting and stopping of equipment and for earthquake bracing. Install bumpers after equipment is in operation to allow proper placement and alignment and ensure that bumpers are not engaged during normal system operation.

## 1.4 RUSTPROOFING

A. General: Design vibration isolation hardware or treat for corrosion resistance.

B. Isolators exposed to weather to have steel parts zinc electroplated, PVC coated, plus coating of neoprene or bitumastic paint. Etch aluminum components for outdoor installation and paint with industrial grade enamel.

C. Nuts, bolts and washers zinc electroplated.

## 1.5 ELECTRICAL CONNECTIONS

A. Make electrical connections to mechanical equipment motors through a flexible conduit designed to reduce motor vibration transfer into the rigid conduit which is directly attached to the building structure.

B. Flexible Conduit: Sufficiently long to provide a 360 degree loop in the flex between the motor and the rigid conduit. Route conduit through side of equipment roof curb and attaching flexible conduit. Caulk around curb penetration water tight.

C. Provide a soft neoprene bushing at the connection point between the flex and the rigid conduit to break the metal-to-metal contact.

D. Ground wires from vibrating equipment to be flexible with sufficient slack to prevent vibration transfer. Ground wires must not directly contact structural membranes (floors, walls or ceilings) of the building.

## 1.6 QUALITY ASSURANCE

A. Coordinate the size, location, and special requirements of vibration isolation equipment and systems with building systems. Coordinate plan dimensions of final selections and mechanical equipment with size of housekeeping pads.

B. Supply and install any incidental materials needed to meet the requirements stated herein.

## 1.7 SUBMITTALS

A. Provide a complete description of products to be supplied including product data, dimensions and specifications. Provide installation instructions for each product.

B. Provide a complete tabulation showing for each piece of vibration isolator supporting equipment the following:
   1. The equipment identification mark.
   2. The isolator type with rated load.
   3. The actual load per isolator.

C. Provide fabrication/shop drawings of steel rails, inertia bases, steel base frames, reinforcing, vibration isolator mounting attachment method, unitary straps and location of equipment attachment bolts.

D. Provide structural calculations for isolator seismic restraint sealed by a professional structural engineer, registered in the state of California.

## PART 2 - PRODUCTS

### 2.1 METAL PARTS INSTALLED OUT-OF-DOORS

A. Cold dip galvanized, cadmium plated or neoprene coated after fabrication.

### 2.2 SEISMIC RESTRAINTS FOR PIPING AND DUCTWORK

A. Use the document "Seismic Restraints Manual Guidelines for Mechanical Systems." Secure piping, ductwork, and the like to withstand a force in any direction.

B. Sway bracing is not required for pipes that are installed on very short hangers (12 inches or less).

C. Secure piping bracing at every fourth hanger transversely and every eighth hanger longitudinally.

D. As approved by code authority, use a bracing system manufactured by Superstrut, Mason, or Pipe Shields Inc., or approved.

E. Design restraints to meet CBC Seismic Restraint requirements. Provide structural engineering calculations sealed by a professional engineer registered in state of California.

### 2.3 EQUIPMENT

A. Provide a means to prohibit excessive motion of mechanical equipment during an earthquake.

B. Provide equipment, both hanging and base mounted, with mounting connection points of sufficient strength to resist lateral seismic forces equal to 0.5 of equipment operating weight.

C. Design restraints to meet CBC Seismic Restraint requirements. Provide structural engineering calculations sealed by a professional engineer registered in state of California.

### 2.4 NEOPRENE PAD (NP)

A. One layer of 5/16-inch thick ribbed or waffled neoprene, 40 to 50 durometer. Size pads for loading between 40 and 50 PSI.

B. NP Isolators: Amber/Booth type NR.

C. Manufacturers: Supply vibration isolation mounts by a single manufacturer. Acceptable suppliers are as follows: Amber/Booth Co. - A.B., Korfund Dynamics - K.D., Mason Industries, Inc. - M.I., Peabody Noise Control Inc. - P.N.C., Vibration Mountings & Controls, Inc. - V.M.&C., IAC, Koppers, Vibrex.

## 2.5 FLEXIBLE DUCT CONNECTIONS (FDC)

A. Neoprene loaded vinyl material or neoprene loaded canvas with vapor barrier. Flame spread rating of 25 or less, and a smoke spread rating of 50 or less, per ASTM E84. Not affected by temperatures as low as minus 10F, or as high as 200F.

B. Flexible Connections: Ventglas manufactured by Ventfabrics, Amatex, or approved.

## 2.6 FLEXIBLE PIPE CONNECTIONS (FPC)

A. Straight, double sphere shape fabricated of multiple plies of nylon cord, fabric and neoprene, vulcanized so as to become inseparable and homogenous. Able to accept compressive, elongative, transverse and angular movements.

B. Select and fit to suit the system temperature, pressure and fluid type. Do not use rods or cables to control extension of the connector.

C. Pipe Sizes 2 Inches or Smaller: Threaded female union couplings on each end. Larger sizes: Metallic flange couplings.

D. FPC: Mason MFTNC.

E. Manufacturers: Supply vibration isolation mounts by a single manufacturer. Acceptable suppliers are as follows: Amber/Booth Co. - A.B., Korfund Dynamics - K.D., Mason Industries, Inc. - M.I., Peabody Noise Control Inc. - P.N.C., Vibration Mountings & Controls, Inc. - V.M.&C., Metraflex, Vibrex.

F. Connections to match piping system.

## 2.7 GROMMETS

A. Combine a neoprene washer and sleeve.

B. Isogrommets manufactured by MBPS, Inc.

C. Series W by Barry Controls, or approved.

D. Neoprene Durometer: Between 40 and 50. Grommets: Specially formed to prevent fastening bolts from directly contacting the isolator base plate.

## 2.8 RESILIENT NONHARDENING SEALANT

A. Sealants for Acoustical Purposes: DAP acoustical sealant.

B. Manufacturers: Pecra, Tremco, USG, or approved.

## 2.9 FOAM RUBBER

A. Foam Rubber Sheets: Armstrong Armaflex, or approved.

## 2.10 ACOUSTICAL WRAP

A. Sound barrier material, designed specifically for sound control, apply for duct/pipe lag material, for indoor or outdoor use. 2.54 mm (0.10 inch) thick barium sulfate loaded limp vinyl sheet bonded to a thin layer of reinforced aluminum foil, on one or both sides:

| | | |
|---|---|---|
| 1. | Nominal Density: | 1.0 lb./ft2 |
| 2. | Thermal Conductivity K: | 0.29 BTU-in/hr-ft2-0F |
| 3. | Rated service Temperature range: | -40F to 220F |
| 4. | Flamespread: | 10 (ASTM E84) |
| 5. | Smoke Developed: | 40 (ASTM E84) |
| 6. | Minimum STC: | 27 |
| 7. | Corrosion Resistance: | most oil, grease, acids and mid alkalis |

B. Sound Transmission Loss (STC):

| Frequency | 125 | 250500 | 1000 | 2000 | 4000 | STC |
|---|---|---|---|---|---|---|
| Transmission Loss dB | 15 | 19 21 | 28 | 33 | 37 | 2 |

C. Manufacturers: Kinetic Noise Control, Inc. (KNM-100AL), Thermafiber Industrial Felt, or approved.

## PART 3 - EXECUTION

## 3.1 APPLICATION

A. General:

1. Set floor-mounted equipment on housekeeping type concrete pads as detailed. Extend pad 6 inches beyond footprint of equipment in each direction.
2. Install flexible duct connections at fan unit intakes, fan unit discharges, and wherever else shown on Drawings.
3. Install flexible pipe connections (FPC) at pipe connections to vibration isolated equipment. Included, but not be limited to, air handling units, pumps, chillers, and cooling towers.
4. Isolate miscellaneous pieces of mechanical equipment, i.e., storage tanks, and expansion tanks from the building structure by NP or HN isolators.
5. Provide mounts for equipment installed outdoors for wind loads of 30 lbs. psf applied to any exposed surface of the isolated equipment.
6. Under no circumstances destroy isolation efficiency by bolting the isolators to the roof or floor or equipment. If bolting is necessary, provide rubber grommets and washers to isolate the bolt from the base plate.
7. Building Penetrations: Isolate water piping and ductwork penetrating wall, ceilings, floors or shafts from the structure by piping isolator or by 3/8-inch thick foamed rubber insulation. Install units flush with finished structure face, using one for each side as required. Cut units to length if longer than structure thickness. Caulk around pipe or duct at equipment room wall.
8. Pipe and Duct Hangers in Equipment Rooms: Support water, piping and ducts connected to rotating equipment within the equipment rooms on spring and neoprene hangers. The first three hangers from a piece of vibrating equipment to have a minimum of 1/2 the static deflection of that of the equipment isolators. Other isolators should have a minimum of 1/4 the static deflection of that of the equipment.

B. Drain Service Piping Connected to Vibration Isolated Equipment: Do not contact the building structure or other nonisolated system unless it is resiliently mounted as described above.

## 3.2 VIBRATION ISOLATION EQUIPMENT INSTALLATION

A. General: Install vibration isolation equipment in accordance with the manufacturer's written instructions.

B. Flexible Duct Connections: Squarely align sheet metal ducts or plenum openings with the fan discharge, fan intake or adjacent duct section prior to installation of the flexible connection, so that the clear length is approximately equal the way around the perimeter. Install connections such that the fan unit or adjacent duct section is able to move 1 inch in any direction without causing metal-to-metal contact or stretching taught the flexible connection. Install the connections so that the clear space between ducts is a minimum of 4 inches, and the connection has a minimum of 1-1/2 inches of slack material. Install flexible connections per SMACNA.

C. Flexible Pipe Connections: Install flexible pipe connections to minimize initial misalignment.

D. Foam Rubber: Provide foam rubber sheets between fan bases and roof mounted equipment curbs and between rooftop mounted HVAC equipment and their curbs.

E. Anchorage: Adequately anchor or brace mechanical equipment, piping and ductwork to resist displacement due to seismic action, include snubbers on equipment mounted on spring isolators, chiller, pump, cooling tower, and the like.

## 3.3 ADJUSTING AND CLEANING

A. Clean each vibration isolator. Verify that each is working freely, and that there is no debris in the immediate vicinity of the unit that could short circuit unit isolation.

B. Schedule:

| Equipment: | Type: |
|---|---|
| Duct Connections to AHU | FDC |
| Air Handler Casings | NP |
| Pipe Connections to AHU's | FPC |

## 3.4 ACCESS PANELS

A. Install wall and ceiling access panels to provide access to concealed valves, fans, motors, shock arrestors, fire dampers, terminal units, coils and other mechanical items needing service. Provide access panels at locations required or specified herein. Coordinate locations/sizes of access panels with Architect prior to work.

**END OF SECTION**

# SECTION 23 05 53

# IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Work Included: Materials and installation of mechanical systems identification.

### 1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of identification devices of types and sizes required.

B. Codes and Standards: Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices, unless otherwise indicated.

### 1.3 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data and installation instructions for each identification material and device required.

B. Schedules: Submit valve schedule for each piping system, typewritten and reproduced on 8-1/2- by 11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), and variations for identification (if any). Mark valves which are intended for emergency shutoff and similar special uses by special "flags" in margin of schedule. In addition to mounted copies, furnish extra copies for maintenance manuals.

## PART 2 - PRODUCTS

### 2.1 MECHANICAL IDENTIFICATION MATERIALS

A. General: Manufacturer's standard products of categories and types required for each application as referenced in other Division 23 sections. Where more than a single type is specified for application, provide single selection for each product category.

B. Manufacturers: Allen Systems, Inc., W. H. Brady Co., Signmark Division, Industrial Safety Supply Co., Inc., Seton Name Plate Corporation, or approved.

### 2.2 PLASTIC PIPE MARKERS

A. Provide one of the following:
   1. Snap-on Type: Manufacturer's standard preprinted, semi-rigid snap-on, color-coded pipe markers.
   2. Pressure-Sensitive Type: Manufacturer's standard preprinted, permanent adhesive, color-coded, pressure sensitive, vinyl pipe markers.

B. Small Pipes: For external diameters less than 6 inches (including insulation, if any), provide full-band pipe markers, extending 360 degrees around pipe at each location, fastened by one of the following methods:
   1. Snap-on application of pretensioned semi-rigid plastic pipe marker.
   2. Adhesive lap joint in pipe marker overlap.
   3. Laminated or bonded application of pipe marker to pipe (or insulation).

4. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 3/4 inch wide; full circle at both ends of pipe marker, tape lapped 1-1/2 inches.

C. Lettering: Comply with piping system nomenclature as specified, scheduled or shown, and abbreviate only as necessary for each application length.

D. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as separate unit of plastic.

## 2.3 PLASTIC DUCT MARKERS

A. General: Manufacturer's standard laminated plastic, color-coded duct markers. Supply separate color codes for supply, exhaust, outside, and return air.

B. Include the Following Nomenclature:
1. Direction of air flow.
2. Duct service (supply, return, exhaust, outdoor air).

## 2.4 VALVE TAGS

A. Brass Valve Tags: Polished brass valve tags with stamp-engraved piping system abbreviation in 1/4-inch high letters and sequenced valve numbers 1/2 inch high, and with hole for fastener. 1-1/2-inch diameter tags, except as otherwise indicated. Valve designations to be coordinated with *existing* valve identifications to ensure no repetitive designations are utilized.

B. Valve Tag Fasteners: Solid brass chain (wire link or beaded type), or solid brass S-hooks.

C. Access Panel Markers: Manufacturer's standard 1/16-inch thick engraved plastic laminate access panel markers, with abbreviations and numbers corresponding to concealed valve. Include center hole to allow attachment.

## 2.5 PLASTIC EQUIPMENT MARKERS

A. General: Manufacturer's standard laminated plastic, color-coded equipment markers. Conform to the following color code:
1. Green: Cooling equipment and components.
2. Yellow: Heating equipment and components.

B. Nomenclature: Match terminology used on drawing schedules as closely as possible.

C. Size: Provide approximate 2-1/2- by 4-inch markers for control devices, dampers, and valves; and 4-1/2- by 6-inch markers for equipment.

## 2.6 LETTERING AND GRAPHICS

A. General: Coordinate names, abbreviations and other designations used in mechanical identification work with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of mechanical systems and equipment.

B. Multiple Systems: Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (as examples: Chiller No. 3, Air Handling Unit No. 42, Standpipe F12, and the like).

## PART 3 - EXECUTION

### 3.1 GENERAL INSTALLATION REQUIREMENTS

A. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

### 3.2 DUCTWORK IDENTIFICATION

A. General: Identify air supply, return, exhaust, and intake ductwork with duct markers, showing ductwork service and direction of flow, in black or white (whichever provides most contrast with ductwork identification color).

B. Location: In each space where ductwork is exposed, locate signs near points where ductwork originates or continues into concealed enclosures (shaft, underground or similar concealment), and at 50 foot spacing along exposed runs.

C. Access Doors: Provide duct markers or stenciled signs on each access door in ductwork and housings, indicating purpose of access (to what equipment) and other maintenance and operating instructions.

D. Dampers: Provide 12-inch, plenum-rated marker ribbon to end of balancing damper handles.

### 3.3 PIPING SYSTEM IDENTIFICATION

A. Install pipe markers on each system and include arrows to show normal direction of flow.

B. Locate pipe markers and color bands wherever piping is exposed to view in occupied spaces, machine rooms, accessible maintenance spaces (shafts, tunnels and plenums), and exterior nonconcealed locations, in locations as follows:

1. Near each valve and control device.
2. Near each branch, excluding short take-offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.
3. Near locations where pipes pass through walls or floors/ceilings, or enter nonaccessible enclosures.
4. At access doors and similar access points which permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced intermediately at maximum spacing of 20 feet along each piping run, except reduce spacing to 10 feet in congested areas of piping and equipment, i.e., mechanical rooms.

### 3.4 VALVE IDENTIFICATION

A. General: Provide valve tag on every valve, cock and control device in each piping system. Exclude check valves, valves within factory fabricated equipment units. List each tagged valve in valve schedule for each piping system.

B. Install mounted valve schedule in each mechanical room.

## 3.5 MECHANICAL EQUIPMENT IDENTIFICATION

A. General: Install engraved plastic laminate sign or plastic equipment marker on or near each item of mechanical equipment and each operational device, as specified herein if not otherwise specified for each item or device. Provide signs for the following general categories of equipment and operational devices: Pumps, compressors, chillers, cooling towers and similar motor driven units, electric duct heaters, terminal units, coils, fans, chillers, boilers, blowers, unitary HVAC equipment, tanks and pressure vessels, filters, water treatment systems and similar equipment.

## 3.6 ADJUSTING AND CLEANING

A. Adjusting: Relocate any mechanical identification device which has become visually blocked.

B. Cleaning: Clean face of identification devices and glass frames of valve charts.

**END OF SECTION**

# SECTION 23 05 93

# TESTING, ADJUSTING AND BALANCING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Work Included: Materials, equipment and labor required for testing, adjusting, and balancing work required by this Section, including air, hydronic systems, and associated equipment and apparatus. The work consists of setting speed and volume (flow) adjustments, recording data, conducting tests, preparing and submitting reports, and recommending modifications to work as required.

### 1.2 SCOPE OF WORK

A. Testing, adjusting, and Balancing (TAB) of the air conditioning systems and related ancillary equipment will be performed by a certified third party independent of the Contractor who specializes in testing, adjusting, and balancing of heating, ventilating, air-moving equipment and hydronic systems and has a minimum of 5 years experience in this specialty.

B. Make changes or replacements to the sheaves, belts, dampers, valves, etc. required for the correct balance as advised the TAB Firm, at no additional cost to the Owner.

C. The Drawings and Specifications indicate valves, dampers, and miscellaneous adjustment devices for the purpose of adjustment to obtain optimum operating conditions, and it will be the responsibility of the Contractor to install these devices in a manner that will leave them accessible and readily adjustable. Should any such device not be readily accessible, provide access as requested by the TAB Firm. Correct equipment malfunction encountered during the balancing process.

D. Complete TAB services prior to Owner occupancy.

### 1.3 QUALIFICATIONS

A. Perform work of this Section by a firm certified by National Environmental Balancing Bureau (NEBB) or Associated Air Balance Council (AABC).

B. Do work of this Section under the direct supervision of a person who has passed written and practical NEBB or AABC examinations for testing, adjusting, and balancing of air and hydronic systems.

### 1.4 QUALITY ASSURANCE

A. Codes and Standards:
   1. NEBB Compliance: Comply with NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" as applicable to mechanical air and hydronic distribution systems, and associated equipment and apparatus; or comply with AABC's Manual MN-1, "AABC National Standards," as applicable to mechanical air and hydronic distribution systems, and associated equipment and apparatus.
   2. Industry Standards: Comply with ASHRAE recommendations pertaining to measurements, instruments, and testing, adjusting and balancing, except as otherwise indicated.

B. Personnel: TAB personnel used on the project will be employees of the Test and Balance Agency. Perform TAB work under the direct supervision of the NEBB or AABC Certified Test and Balance Supervisor.

C. Instrumentation:
1. List in balance report instrument description, serial number, and date of calibration.
2. Use instruments calibrated no longer than 1 year prior to report submission.

## 1.5 SUBMITTALS

A. Procedures: Submit certified test reports, signed by TAB supervisor who performed TAB work.

B. Qualification Statements: Submit company's certification documents including Contractor Certification and Supervisor certification.

C. Report Forms:
1. Submit copies of report forms to Architect within 30 days of award of the Contract by Owner prior to commencement of testing and balancing work at the site.
2. Provide 8-1/2- by 11-inch paper for looseleaf binding, with blanks for listing the required test ratings and for certification of report.
3. Submit reports on forms similar in content to standard AABC or NEBB test forms.
4. Submit final test and balance report. Include Record Drawings with terminal codes for cross-reference with the Submittal, such that terminals referenced in the Submittal are easily located on the Drawings.
5. Include identification and types of instruments used, and their most recent calibration date.
6. Submit resume data on person who is to directly supervise testing, adjusting and balancing work.

D. Maintenance Data: Include copies of balancing report and identification of instruments in maintenance manuals.

E. NEBB or AABC Certificate: At time of submittal of forms, submit NEBB or AABC certification form for review.

## 1.6 WARRANTY

A. TAB Agency provides warranty for a period of 90 days following submission of completed report, during which time, Owner may request a recheck of up to 10 percent of total number of terminals, or resetting of any outlet, coil, or device listed in the final TAB report.

B. Warranty shall meet the requirements of the following programs:
1. AABC – National Project Performance Guarantee
2. NEBB – Conformance Certification

# PART 2 - PRODUCTS

## 2.1 PATCHING MATERIALS

A. Ductwork and Housings: Use plastic plugs with retainers to patch drilled holes.

## 2.2 INSTRUMENTS

A. Utilize test instruments and equipment as recommended in the following:
   1. NEBB's Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems.
   2. AABC's Manual MN-1, "AABC National Standards."

# PART 3 - EXECUTION

## 3.1 VERIFICATION OF CONDITIONS

A. Perform TAB work with doors, closed windows, and ceilings installed, etc., to obtain simulated or project operating conditions. Do not proceed until systems scheduled for testing, adjusting and balancing are clean and free from debris, dirt and discarded building materials.

B. Verify the following:
   1. Equipment is operable and normal condition.
   2. Temperature control systems are installed complete and operable.
   3. Final filters are clean and in place.
   4. Duct systems are clean of debris.
   5. Fan rotation is correct.
   6. Dampers are in place and open.
   7. Access doors are closed.
   8. Air outlets are installed and connected.
   9. Hydronic Systems have been flushed, filled, and vented.
   10. Proper strainer baskets are clean and in place.
   11. Service and balance valves are open.
   12. Any conditions affecting system operation, such as open doors, adjacent pressurized areas, and the like, are in final operating conditions prior to testing and balancing.

C. Report any defects or deficiencies noted during performance of services to Architect and Commissioning Agent. Promptly report abnormal conditions in Mechanical Systems or conditions which prevent system balance.

D. Automatic Temperature Control Systems:
   1. Set and adjust automatically operated devices to achieve required sequence of operations. Coordinate with the automatic temperature control supplier. Do not proceed without his representation.
   2. Verify controls for proper calibration and correct as necessary.

## 3.2 TEST HOLE LOCATIONS

A. Install test holes at the inlet and outlet of air handling unit fans, exhaust fans, utility fans, and the like, and elsewhere as required to facilitate traverses and to test the air systems. Plug holes when finished. Install test holes in air handlers to obtain test data for each component.

## 3.3 AIR SYSTEM PROCEDURE

A. Adjust air handling and distribution systems to provide required or design supply, return, outside, and exhaust air quantities.

B. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.

C. Measure air quantities at air inlets and outlets. Log shows each successive test.

D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.

E. Use volume control devices to regulate air quantities only to the extent that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.

F. Vary total system air quantities by adjustment of fan speeds. Vary branch air quantities by damper regulation.

G. Adjust fans to deliver within 5 percent of specified flow. Adjust air outlets and inlets to within 10 percent of specified flow. Adjust to obtain balance with minimum fan speed possible.

H. Adjust fan for variable air volume systems with terminal units at 50 percent cooling airflow, opening terminal units at end of controlling duct run to achieve fan flow specified. Report final duct static pressure setpoint and supply fan and exhaust/return fan VFD speeds and frequencies.

I. Adjust outside air to fans as scheduled. Measure outside air for variable air volume fans at full flow. Adjust belt driven fan speeds to obtain necessary flow with variable frequency drive at 60 Hertz.

J. Adjust relief exhaust fans on variable air volume systems to maintain a positive building static pressure of 0.05 inch w.c. Verify and document calibration of building static pressure sensors.

## 3.4 AIR MOVING EQUIPMENT TESTING

A. Location.

B. Manufacturer.

C. Model.

D. Supply airflow, specified and actual.

E. Return airflow, specified and actual.

F. Outside airflow, specified and actual.

G. Total external static pressure, specified and actual.

H. Inlet pressure.

I. Discharge pressure.

J. Fan RPM.

## 3.5 EXHAUST FAN TESTING

A. Location

B. Manufacturer.

C. Model.

D. Airflow, specified and actual.

E. Total external static pressure, specified and actual.

F. Inlet pressure.

G. Discharge pressure.

H. Fan RPM.

## 3.6 RETURN AIR/OUTSIDE AIR TESTING

A. Identification/location.

B. Design airflow.

C. Actual airflow.

D. Design return airflow.

E. Actual return airflow.

F. Design outside airflow.

G. Actual outside airflow.

H. Return air temperature.

I. Outside air temperature.

J. Required mixed air temperature.

K. Actual mixed air temperature.

L. Design outside/return air ratio.

M. Actual outside/return air ratio.

## 3.7 ELECTRIC MOTORS TESTING

A. Manufacturer.

B. HP/BHP.

C. Phase, voltage, amperage; nameplate, actual, no load. Record voltage and amperage on all phases of 3 phase motors.

D. RPM.

E. Service factor.

F. Starter size, rating, heater elements.

## 3.8 V-BELT DRIVES TESTING

A. Identification/location.

B. Required driven RPM.

C. Driven sheave, diameter and RPM.

D. Belt, size and quantity.

E. Motor sheave, diameter and RPM.

## 3.9 DUCT TRAVERSE TESTING

A. System zone/branch.

B. Duct size.

C. Area.

D. Design velocity.

E. Design airflow.

F. Test velocity.

G. Test airflow.

H. Duct static pressure.

I. Air temperature.

J. Air correction factor.

## 3.10 AIR DISTRIBUTION TESTING

A. Air terminal number.

B. Room number/location.

C. Terminal type.

D. Terminal size.

E. Design velocity.

F. Design airflow.

G. Test (final) velocity.

H. Test (final) airflow.

I. Percent of design airflow.

## 3.11 TERMINAL UNIT TESTING

A. Manufacturer.

B. Type (i.e., constant, variable, single, dual duct).

C. Identification/number.

D. Location.

E. Model.

F. Size.

G. Minimum static pressure.

H. Minimum design airflow.

I. Maximum design airflow.

J. Maximum actual airflow.

K. Inlet static pressure.

L. Inlet and outlet temperature with heating valve open.

M. Coil water pressure drop, inlet and outlet temperatures and flowrate.

## 3.12 DUCT PRESSURE SENSOR (VAV SYSTEM) TESTING

A. Location.

B. Static pressure with fan at block load airflow.

## 3.13 WATER SYSTEM PROCEDURES

A. Adjust water systems to provide required or design quantities. Use calibrated orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on pressure drop across various heat transfer elements in the system.

B. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.

C. Effect system balance with automatic control valves fully open to heat transfer elements.

D. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shutoff valves for balancing unless indexed for balance point.

E. Adjust differential pressure on variable flow systems to minimum value that produces design flows to equipment.

## 3.14 COOLING COIL TESTING

A. Identification/number.

B. Location.

C. Service.

D. Manufacturer.

E. Airflow, design and actual.

F. Entering air DB temperature, design and actual.

G. Entering air WB temperature, design and actual.

H. Leaving air DB temperature, design and actual.

I. Leaving air WB temperature, design and actual.

J. Water flow, design and actual.

K. Water pressure drop, design and actual.

L. Entering water temperature, design and actual.

M. Leaving water temperature, design and actual.

N. Air pressure drop, design and actual.

## 3.15 HEATING COIL TESTING

A. Identification/number.

B. Location.

C. Service.

D. Manufacturer.

E. Airflow, design and actual.

F. Water flow, design and actual.

G. Water pressure drop, design and actual.

H. Entering water temperature, design and actual.

I. Leaving water temperature, design and actual.

J. Entering air temperature, design and actual.

K. Leaving air temperature, design and actual.

L. Air pressure drop, design and actual.

## 3.16 ADJUSTING

A. Recorded data represents actually measured or observed conditions. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops. Adjust air systems to deliver specified volumes with lowest possible fan speed.

## 3.17 DOMESTIC WATER

A. Adjust domestic water recirculation system to ensure hot water circulation in mains.

**END OF SECTION**

# SECTION 23 07 00

# HVAC INSULATION

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Piping and Equipment Insulation: Materials and installation of insulation, jackets and accessories for the following applications:
   1. Chilled water piping systems.
   2. Heating water piping systems.

B. Ductwork Insulation: Materials and installation of duct insulation including the following applications: Air conditioning and heating ductwork.

### 1.2 QUALITY ASSURANCE

A. Qualification of Workers: Use proficient journeyman insulators and supervisors in the execution of this portion of the work to ensure proper and adequate installation of insulation throughout. A firm with at least 5 years successful installation experience on projects with installations similar to that required for this project.

B. Compliance with Specifications:
   1. Whenever required during progress of the work, furnish proof acceptable to the Owner that items installed are equal to or exceed requirements specified for this work.
   2. In the event such proof is not available, or is not acceptable to the Owner, the Owner may require the Contractor to remove the item or items and replace with material meeting the specified requirements and to repair damage caused in the removal and replacement, at no additional cost to the Owner.
   3. Install per manufacturer's written instructions.
   4. As a minimum, comply with appropriate state energy code or other applicable codes.

### 1.3 SUBMITTALS

A. Product Data: Submit manufacturer's technical data and installation instructions for each type of insulation, jacket, glue, paint, fitting cover, and accessory. Submit schedule showing manufacturer's product number, thickness, and furnished accessories for each piping, equipment and duct system requiring insulation.

### 1.4 PRODUCT HANDLING

A. Protection: Use means necessary to protect insulation materials before, during and after installation.

B. Replacements: In the event of damage, immediately make repairs and replacements necessary.

## 1.5 FIRE HAZARD CLASSIFICATION

A. Maximum fire hazard classification of the composite insulation construction as installed to be not more than a flame spread of 25, fuel contributed of 50 and smoke developed of 50 as tested by ASTM E84 (NFPA 255) method.

B. Test pipe insulation in accordance with the requirements of UL "Pipe and Equipment Coverings R5583 400 8.15."

C. Test duct insulation in accordance with ASTM E84 and bear the UL label.

## 1.6 LINING MATERIALS

A. Materials to be mold-, humidity-, and erosion-resistant surface that meets the requirements of UL 181.

# PART 2 - PRODUCTS

## 2.1 MANUFACTURERS

A. Piping: Armacell LLC Armaflex, Certainteed, Imcoa, Johns Manville, Knauf, Nomaco, Owens-Corning, PPG, or approved.

B. Ductwork: Armacell LLC Armaflex, Certainteed, Johns Manville, Knauf, Owens-Corning, PPG, or approved.

## 2.2 TYPE 1, FIBERGLASS PIPE INSULATION

A. Glass Fiber: ASTM C547; rigid molded, noncombustible.
   1. Thermal Conductivity Value: 0.27 at 75F.
   2. Maximum Service Temperature: 850F.
   3. Vapor Retarder Jacket: White Kraft paper reinforced with glass fiber and bonded to aluminum foil, secure with self sealing longitudinal laps and butt strips or AP Jacket with outward clinch expanding staples or vapor barrier mastic as needed.

## 2.3 TYPE 5, PLASTIC PIPE INSULATION

A. Flexible unicellular polyolefin foam insulation complying to ASTM C534, ASTM E84 (25/50), UL 723 (25/50). Thermal conductivity of 0.24 (BTU/in)/(hr/sq.ft./deg. F) at 75F. Preslit longitudinal seam. Imcoa, or approved.

## 2.4 TYPE 7, FLEXIBLE FIBERGLASS BLANKET

A. ASTM C553, Type 1, Class B-2; flexible blanket.

B. 'K' Value: 0.27 at 75F installed.

C. Density: 0.75 lb./cu.ft.

D. Vapor Barrier Jacket: FSK aluminum foil reinforced with fiberglass yarn and laminated to fire resistant Kraft, secured with UL listed pressure sensitive tape or outward clinched expanded staples and vapor barrier mastic as needed.

## 2.5 TYPE 8, DUCT LINER

A. ASTM C1071; flexible blanket.

B. 'K' Value: ASTM C518, 0.25 at 75F.

C. Noise Reduction Coefficient: 0.65 or higher based on "Type A mounting."

D. Maximum Velocity on Mat or Coated Air Side: 5,000 FPM

E. Adhesive: UL listed waterproof type.

F. Fasteners: Duct liner galvanized steel pins, welded or mechanically fastened.

G. Mold-, Humidity-, and Erosion-Resistant Surfaces: UL 181.

## 2.6 JACKETING

A. PVC Plastic Fitting Covers: Schuller Zeston 2000. One-piece molded type fitting covers and jacketing material, gloss white. Connections: Tacks; pressure sensitive color matching vinyl tape.

B. Canvas Jacket: UL listed fabric, 6 oz/sq.yd., plain weave cotton treated with dilute fire retardant lagging adhesive.

## 2.7 ACCESSORIES

A. Equipment Insulation Jacketing: Presized glass cloth, not less than 7.8 ounces/sq.yd., except as otherwise indicated. Coat with gypsum based cement.

B. Equipment Insulation Compounds: Provide adhesives, cement, sealers, mastics and protective finishes as recommended by insulation manufacturer for applications indicated.

C. General: Provide staples, bands, wire, wire netting, tape corner angles, anchors, stud pins and metal covers as recommended by insulation manufacturer for applications indicated. Accessories, i.e., adhesives, mastics, cements and tape to have the same flame and smoke component ratings as the insulation materials with which they are used. Shipping cartons to bear a label indicating that flame and smoke ratings do not exceed those listed above. Provide permanent treatment of jackets or facings to impart flame and smoke safety. Provide nonwater soluble treatments.

## 2.8 PIPE FITTING INSULATION COVERS

A. PVC preformed molded insulation covers. Zeston, or approved.

## 2.9 DUCT INSULATION ACCESSORIES

A. Staples, bands, wires, tape, anchors, corner angles and similar accessories as recommended by insulation manufacturer for applications indicated.

## 2.10 DUCT INSULATION COMPOUNDS

A. Cements, adhesives, coatings, sealers, protective finishes and similar accessories as recommended by insulation manufacturer for applications indicated.

## PART 3 - EXECUTION

### 3.1 VERIFICATION OF CONDITIONS

A. Do not apply insulation until pressure testing of the ducts has been completed. Do not apply insulation until the duct has been inspected.

B. Examine areas and conditions under which duct insulation will be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

A. Clean and dry surfaces to be insulated.

### 3.3 INSTALLATION

A. Insulation: Continuous through walls, floors, partitions except where noted otherwise.

B. Piping and Equipment: Install insulation over clean, dry surfaces with adjoining sections firmly butted together and covering surfaces. Fill voids and holes. Seal raw edges. Install insulation in a manner such that the insulation may be split, removed, and reinstalled with vapor barrier tape on strainer caps and unions. Do not install insulation until the piping has been leak tested and has passed such tests. Do not insulate chiller manholes, equipment manufacturer's nameplates, handholes, and ASME stamps. Provide beveled edge at such insulation interruptions. Repair voids or tears.

C. Ductwork:
1. Install insulation in conformance with the manufacturer's recommendations to completely cover the duct.
2. Butt insulation joints firmly together and install jackets and tapes smoothly and securely.
3. Apply duct insulation continuously through sleeves and prepared openings, except as otherwise specified. Apply vapor barrier materials to form a complete unbroken vapor seal over the insulation.
4. Coat staples and seals with vapor barrier coating.
5. Cover breaks in the jacket material with patches of the same material as the vapor barrier. Extend the patches not less than 2 inches beyond the break or penetration in all directions and secure with adhesive and staples. Seal staples and joints with brush coat of vapor barrier coating.
6. Fill jacket penetrations, i.e., hangers, thermometers and damper operating rods, and other voids in the insulation with vapor barrier coating. Seal the penetration with a brush coat of vapor barrier coating.
7. Seal and flash insulation terminations and pin punctures with a reinforced vapor barrier coating.
8. Continue insulation at fire dampers up to and including those portions of the fire damper frame which are visible at the outside of the rated fire barrier. Insulation terminations at fire dampers in accordance with the above.
9. Do not conceal duct access doors with insulation. Install insulation terminations at access doors in accordance with the above.

10. Duct Liners: Install mat finish surface on air stream side. Secure insulation to cleaned sheet metal duct with a continuous 100 percent coat of adhesive. For widths over 20 inches, additionally secure the liner with mechanical fasteners 15 inches on center. Accurately cut liner and thoroughly coat ends with adhesive. Butt joints tightly. Top and bottom sections of insulation overlap sides. Keep duct liner clean and free from dust. At completion of project, vacuum duct liner if it is dirty or dusty. Cut studs off near washers. Do not use small pieces. If insulation is installed without horizontal, longitudinal, and end joints butted together, installation will be rejected and work removed and replaced with work that conforms to this Specification.
11. Duct Wrap: Cover supply air ducts except ducts internally lined. Wrap tightly with circumferential joints butted and longitudinal joints overlapped minimum of 2 inches. Adhere insulation with 4-inch strips of insulating bending adhesive at 8 inches on center. On ducts over 24 inches wide, additionally secure insulation with suitable mechanical fasteners at 18 inches on center. Circumferential and longitudinal joints stapled with flare staples 6 inches on center and covered with 3-inch-wide, foil reinforced tape.

## 3.4 PROTECTION AND REPLACEMENT

A. Protect installed insulation during construction. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.

## 3.5 FIBERGLASS INSULATION

A. Lap seal insulation with waterproof adhesive. Do not use staples or other methods of attachment which would penetrate the vapor barrier. Apply fitting covers with seated tacks and vapor barrier tape.

B. Apply insulation to pipe and seal with self-sealing lap. Use self-sealing butt strips to seal butt joints. Insulate fittings, valves and unions with single or multiple layers of insulation and cover to match pipe or use preformed PVC molded insulation covers.

## 3.6 PIPING SURFACES TO BE INSULATED

| Item to be Insulated: | System Insulation Type: | Pipe Size: | Insulation Thickness: |
|---|---|---|---|
| Aboveground heating and piping. | 1, 5 | Runouts up to 2"<br>All others | 1"<br>1-1/2" |
| Chilled, heating water valves. | 5 | N/A | 1" |
| Aboveground chilled, heating in Mechanical Room | 1, 5 | <2"<br>2-1/4 to 6"<br>6" | 1-1/2"<br>2"<br>2-1/2" |
| Condensate drain piping. | 1, 5 | all | 1/2" |

Note: Insulation thickness shown is a minimum. If state codes require additional thickness, then provide insulation thickness per code requirements.

## 3.7 DUCTWORK SURFACES TO BE INSULATED

| Item to be Insulated: | System Insulation Type: | Duct Size: | Insulation Thickness: |
|---|---|---|---|
| Supply ductwork (where duct is not specified to be lined). | 7 | all | 1-1/2" |
| Supply and return ductwork (in Mechanical Room). | 7 | all | 2" |
| Supply ductwork (where duct is specified to be lined) | 8 | all | 1" |

Note: Insulation thickness shown is a minimum. If state codes require additional thickness, then provide insulation thickness per code requirements, such as providing R-8 duct insulation outdoors.

## 3.8 INSULATED PIPE EXPOSED TO WEATHER

A. Where piping is exposed on roof, cover insulation with aluminum jacket. Seal watertight jacket per manufacturer's recommendations. Provide heat tracing on piping subject to freezing.

## 3.9 FLEXIBLE ELASTOMERIC TUBING

A. Slip insulation over piping or if piping is already installed, it should be slit and snapped over the piping. Joints and butt ends must be adhered with 520 adhesive.

## 3.10 INSULATION SHIELDS

A. Provide full size diameter hangers and shields (18 gauge minimum) for cold piping. Hot water piping hangers may penetrate insulation to contact pipe directly. Provide 18-inch long, noncompressible insulation section at insulation shields for lines 2 inches and larger (cold piping).

**END OF SECTION**

# SECTION 23 08 00
# COMMISSIONING of HVAC

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

B. OPR, BoD, and BoD-HVAC documentation prepared by Owner and Architect contains requirements that apply to this Section.

### 1.2 SUMMARY

A. This Section includes requirements for commissioning the HVAC system and its subsystems and equipment. This Section supplements the general requirements specified in Division 1 Section "General Commissioning Requirements."

B. Related Sections include the following:

1. Division 1 Section 01 91 13 General Commissioning Requirements for general requirements for commissioning processes that apply to this Section.

### 1.3 DEFINITIONS

A. Architect: Includes Architect identified in the Contract for Construction between College and Contractor, plus consultant/design professionals responsible for design of HVAC, electrical, communications, controls for HVAC systems, and other related systems.

B. BoD: Basis of Design.

C. BoD-HVAC: HVAC systems basis of design.

D. CxA: Commissioning Authority.

E. OPR: Owner's (College) Project Requirements.

F. Systems, Subsystems, and Equipment: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, and equipment.

G. TAB: Testing, Adjusting, and Balancing.

### 1.4 CONTRACTOR'S RESPONSIBILITIES

A. The following responsibilities are in addition to those specified in Division 1 Section "General Commissioning Requirements."

B. Contractor:
1. Attend procedures meeting for TAB Work.
2. Certify that TAB Work is complete.

C. Mechanical Subcontractor:
1. Attend TAB verification testing.
2. Provide measuring instruments and logging devices to record test data, and data acquisition equipment to record data for the complete range of testing for the required test period.

D. HVAC Instrumentation and Control Subcontractor: With the CxA, review control designs for compliance with the OPR and BoD, controllability with respect to actual equipment to be installed, and recommend adjustments to control designs and sequence of operation descriptions.

E. TAB Subcontractor:

1. Contract Documents Review: With the CxA, review the Contract Documents before developing TAB procedures.

a. Verify the following:

1) Accessibility of equipment and components required for TAB Work.

2) Adequate number and placement of duct balancing dampers to allow proper balancing while minimizing sound levels in occupied spaces.

3) Adequate number and placement of balancing valves to allow proper balancing and recording of water flow.

4) Adequate number and placement of test ports and test instrumentation to allow reading and compilation of system and equipment performance data needed to conduct both TAB and commissioning testing.

5) Air and water flow rates have been specified and compared to central equipment output capacities.

b. Identify discontinuities and omissions in the Contract Documents.

c. This review of the Contract Documents by the TAB Subcontractor satisfies requirements for a design review report as specified in Division 23 Section "Testing, Adjusting, and Balancing."

2. Additional Responsibilities: Participate in tests specified in Division 23 Sections "HVAC Instrumentation and Controls" and "Sequence of Operation."

F. Electrical Subcontractor:

1. With the Mechanical Subcontractor, coordinate installations and connections between and among electrical and HVAC systems, subsystems, and equipment.
2. Attend TAB verification testing.

## 1.5 COMMISSIONING DOCUMENTATION

A. The following are in addition to documentation specified in Division 1 Section "General Commissioning Requirements."

B. BoD HVAC: Owner will provide BoD-HVAC documents, prepared by Architect and approved by College Representative, to the CxA and Contractor for use in developing the commissioning plan, systems manual, and operation and maintenance training plan.

C. Test Checklists: CxA with assistance of Architect shall develop test checklists for HVAC systems, subsystems, and equipment, including interfaces and interlocks with other systems. CxA shall prepare separate checklists for each mode of operation and provide space to indicate whether the mode under test responded as required. In addition to the requirements specified in Division 1 Section "General Commissioning Requirements," checklists shall include, but not be limited to, the following:

1. Calibration of sensors and sensor function.
2. Testing conditions under which test was conducted, including (as applicable) ambient conditions, set points, override conditions, and status and operating conditions that impact the results of test.
3. Control sequences for HVAC systems.
4. Responses to control signals at specified conditions.
5. Sequence of response(s) to control signals at specified conditions.
6. Narrative description of observed performance of systems, subsystems, and equipment. Notation to indicate whether the observed performance at each step meets the expected results.
7. Interaction of auxiliary equipment.
8. Issues log.

1.6 SUBMITTALS

The following submittals are in addition to those specified in Division 1 Section "General Commissioning Requirements."

A. Testing Procedures: CxA shall submit detailed testing plan, procedures, and checklists for each series of tests. Submittals shall include samples of data reporting sheets that will be part of the reports.

B. Certificate of Readiness: CxA shall compile certificates of readiness prepared by Contractor certifying that systems, subsystems, equipment, and associated controls are ready for testing.

C. Certificate of Completion of Installation, Prestart, and Startup: CxA shall certify that installation, prestart, and startup activities have been completed. Certification shall include completed checklists provided by TAB Subcontractor as specified in Division 23 Section "Testing, Adjusting, and Balancing." and the Pre-Functional Checklist by the Controls Contractor

D. Certified Pipe Cleaning and Flushing Report: CxA shall certify that pipe cleaning, flushing, hydrostatic testing, and chemical treating have been completed.

E. Test and Inspection Reports: CxA shall compile and submit test and inspection reports and certificates, and shall include them into the systems manual and commissioning report.

F. Corrective Action Documents: CxA shall submit corrective action documents.

G. Certified TAB Reports: CxA shall submit verified, certified TAB reports.

PART 2 - PRODUCTS

The following products and services providers will be directly involved in the commissioning of the building system:

A. Schneider Electric
Enterprise Server Web Interface System

PART 3 - EXECUTION

3.1 TESTING PREPARATION

A. Prerequisites for Testing:

1. Certify that HVAC systems, subsystems, and equipment have been completed, calibrated, and started; are operating according to the OPR, BoD, and Contract Documents; and that Certificates of Readiness are signed and submitted.
2. Certify that HVAC instrumentation and control systems have been completed and calibrated; are operating according to the OPR, BoD, and Contract Documents; and that pretest set points have been recorded.
3. Certify that TAB procedures have been completed, and that TAB reports have been submitted, discrepancies corrected, and corrective work approved.
4. Test systems and intersystem performance after approval of test checklists for systems, subsystems, and equipment.
5. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shut down, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
6. Verify each operating cycle after it has been running for a specified period and is operating in a steady-state condition.
7. Inspect and verify the position of each device and interlock identified on checklists. Sign off each item as acceptable, or failed. Repeat this test for each operating cycle that applies to system being tested.
8. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.
9. Annotate checklist or data sheet when a deficiency is observed.
10. Verify equipment interface with monitoring and control system and TAB criteria; include the following as applicable:

    a. Supply and return flow rates for VAV and constant volume systems in each operational mode.
    b. Operation of terminal units in both heating and cooling cycles.
    c. Minimum outdoor-air intake in each operational mode and at minimum and maximum airflows.
    d. Building pressurization.
    e. Total exhaust airflow and total outdoor-air intake.
    f. Operation of indoor-air-quality monitoring systems.

11. Verify proper responses of monitoring and control system controllers and sensors to include the following:

    a. For each controller or sensor, record the indicated monitoring and control system reading and the test instrument reading. If initial test indicates that the test reading is outside of the control range of the installed device, check calibration of the installed device and adjust as required. Retest malfunctioning devices and record results on checklist or data sheet.
    b. Report deficiencies and prepare an issues log entry.

12. Verify that HVAC equipment field quality-control testing has been completed and approved. CxA shall direct, witness, and document field quality-control tests, inspections, and startup specified in individual Division 23 Sections.

B. Testing Instrumentation: Install measuring instruments and logging devices to record test data for the required test period. Instrumentation shall monitor and record full range of operating conditions and shall allow for calculation of total capacity of system for each mode of operation.

For individual room cooling tests, provide temporary heaters to impose a cooling load indicated in BoD. Operational modes include the following:

1. Occupied and unoccupied.
2. Warm up and cool down.
3. Economizer cycle.
4. Emergency power supply.
5. Life-safety and safety systems.
6. Smoke control.
7. Fire safety.
8. Stair pressurization system.
9. Temporary upset of system operation.
10. Partial occupancy conditions.
11. Special cycles.

3.2 TAB VERIFICATION

A. TAB Subcontractor shall coordinate with CxA for work required in Division 15 Section "Testing, Adjusting, and Balancing." TAB Subcontractor shall copy CxA with required reports, sample forms, checklists, and certificates.

B. Contractor, HVAC Subcontractor, and CxA shall witness TAB Work.

C. TAB Preparation:

1. TAB Subcontractor shall provide CxA with data required for "Pre-Field TAB Engineering Reports" specified in Division 23 Section "Testing, Adjusting, and Balancing."

a. CxA shall use this data to certify that prestart and startup activities have been completed for systems, subsystems, and equipment installation.

D. Ductwork Air Leakage Testing:

1. Architect will identify, for HVAC Subcontractor and CxA, portions of duct systems to have ductwork air leakage testing. Ductwork air leakage testing shall be performed according to Division 23 Section "Metal Ducts," and shall be witnessed by the CxA.
2. On approval of preliminary ductwork air leakage testing report, the CxA shall coordinate verification testing of ductwork air leakage testing. Verification testing shall include random retests of portions of duct section tests, reported in preliminary ductwork air leakage testing report. The HVAC Subcontractor shall perform tests using the same instrumentation (by model and serial number) as for original testing; the CxA shall witness verification testing.

E. Verification of Final TAB Report:

1. CxA shall select, at random, 10 percent of report for field verification.
2. CxA shall notify TAB Subcontractor 10 days in advance of the date of field verification; however, notice shall not include data points to be verified. The TAB Subcontractor shall use the same instruments (by model and serial number) that were used when original data were collected.
3. Failure of an item is defined as follows:

a. For all readings other than sound, a deviation of more than 10 percent.
1) For sound pressure readings, a deviation of 3 dB. (Note: Variations in background noise must be considered.)

4. Failure of more than 10 percent of selected items shall result in rejection of final TAB report.

F. If deficiencies are identified during verification testing, CxA shall notify the HVAC Subcontractor and Architect, and shall take action to remedy the deficiency. Architect shall review final tabulated checklists and data sheets to determine if verification is complete and that system is operating according to the Contract Documents.

G. CxA shall certify that TAB Work has been successfully completed.

3.3 TESTING

A. Test systems and intersystem performance after test checklists for systems, subsystems, and equipment have been approved.

B. Perform tests using design conditions whenever possible.

1. Simulate conditions by imposing an artificial load when it is not practical to test under design conditions and when written approval for simulated conditions is received from CxA. Before simulating conditions, calibrate testing instruments. Set and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
2. Alter set points when simulating conditions is not practical and when written approval is received from CxA.
3. Alter sensor values with a signal generator when design or simulating conditions and altering set points are not practical. Do not use sensor to act as signal generator to simulate conditions or override values.

C. Scope of HVAC Subcontractor Testing:

1. Testing scope shall include entire HVAC installation, from central equipment for heat generation and refrigeration through distribution systems to each conditioned space. It shall include measuring capacities and effectiveness of operational and control functions.
2. Test all operating modes, interlocks, control responses, responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.

D. Detailed Testing Procedures: CxA, with HVAC Subcontractor, TAB Subcontractor, and HVAC Instrumentation and Control Subcontractor, shall prepare detailed testing plans, procedures, and checklists for HVAC systems, subsystems, and equipment.

E. Boiler Testing and Acceptance Procedures: Testing requirements are specified in Division 23 boiler Sections. CxA shall review and comment on submittals, test data, inspector record, and boiler certification and shall compile information for inclusion in systems manual.

F. HVAC Instrumentation and Control System Testing:

1. Field testing plans and testing requirements are specified in Division 23 Sections "HVAC Instrumentation and Controls" and "Sequence of Operation." The CxA, HVAC Subcontractor, and the HVAC Instrumentation and Control Subcontractor shall collaborate to prepare testing plans.

2. CxA shall convene a meeting of appropriate entities to review test report of HVAC instrumentation and control systems.

G. Pipe cleaning, flushing, hydrostatic tests, and chemical treatment requirements are specified in Division 15 piping Sections. HVAC Subcontractor shall prepare pipe system cleaning, flushing, and hydrostatic testing. CxA shall review and comment on plan and final reports. CxA shall certify that pipe cleaning, flushing, hydrostatic tests, and chemical treatment have been completed. Plan shall include the following:

1. Sequence of testing and testing procedures for each section of pipe to be tested, identified by pipe zone or sector identification marker. Markers shall be keyed Drawings for each pipe sector showing the physical location of each designated pipe test section. Drawings keyed to pipe zones or sectors shall be formatted to allow each section of piping to be physically located and identified when referred to in pipe system cleaning, flushing, hydrostatic testing, and chemical treatment plan.
2. Description of equipment for flushing operations.
3. Minimum flushing water velocity.
4. Tracking checklist for managing and ensuring that all pipe sections have been cleaned, flushed, hydrostatically tested, and chemically treated.

H. Energy Supply System Testing: HVAC Subcontractor shall prepare a testing plan to verify performance of systems and equipment. Plan shall include the following:

1. Sequence of testing and testing procedures for each equipment item and pipe section to be tested, identified by pipe zone or sector identification marker. Markers shall be keyed to Drawings for each pipe sector showing the physical location of each designated pipe test section. Drawings keyed to pipe zones or sectors shall be formatted to allow each section of piping to be physically located and identified when referred to in system testing plan.
2. Tracking checklist for managing and ensuring that all pipe sections have been tested.

I. Heat-Generation System Testing: HVAC Subcontractor shall prepare a testing plan to verify performance of boilers, feedwater equipment, furnaces, and auxiliary equipment. Plan shall include the following:

1. Sequence of testing and testing procedures for each item of equipment and section of pipe to be tested, identified by identification marker. Markers shall be keyed to Drawings for each pipe sector showing the physical location of each item of equipment and pipe test section. Drawings shall be formatted to allow each item of equipment and section of piping to be physically located and identified when referred to in the system testing plan.
2. Tracking checklist for managing and ensuring that all pipe sections have been tested.

J. Refrigeration System Testing: HVAC Subcontractor shall prepare a testing plan to verify performance of chillers, cooling towers, refrigerant compressors and condensers, heat pumps, and other refrigeration systems. Plan shall include the following:

1. Sequence of testing and testing procedures for each item of equipment and section of pipe to be tested, identified by identification marker. Markers shall be keyed to Drawings showing the physical location of each item of equipment and pipe test section. Drawings shall be formatted to allow each item of equipment and section of piping to be physically located and identified when referred to in the system testing plan.
2. Tracking checklist for managing and ensuring that all pipe sections have been tested.

K. HVAC Distribution System Testing: HVAC Subcontractor shall prepare a testing plan to verify performance of air, steam, and hydronic distribution systems; special exhaust; and other distribution systems. Include HVAC terminal equipment and unitary equipment. Plan shall include the following:

1. Sequence of testing and testing procedures for each item of equipment and section of pipe to be tested, identified by identification marker. Markers shall be keyed to Drawings showing the physical location of each item of equipment and pipe test section. Drawings shall be formatted to allow each item of equipment and section of piping to be physically located and identified when referred to in the system testing plan.

2. Tracking checklist for managing and ensuring that all pipe sections have been tested.

L. Vibration and Sound Tests: HVAC Subcontractor shall prepare testing plans to verify performance of vibration isolation and seismic controls. CxA shall witness and certify tests and inspections.

M. Deferred Testing:

1. If tests cannot be completed because of a deficiency outside the scope of the HVAC system, the deficiency shall be documented and reported to Owner. Deficiencies shall be resolved and corrected by appropriate parties and test rescheduled.

2. If the testing plan indicates specific seasonal testing, appropriate initial performance tests shall be completed and documented and additional tests scheduled.

N. Testing Reports:

1. Reports shall include measured data, data sheets, and a comprehensive summary describing the operation of systems at the time of testing.

2. Include data sheets for each controller to verify proper operation of the control system, the system it serves, the service it provides, and its location. For each controller, provide space for recording its readout, the reading at the controller's sensor(s), plus comments. Provide space for testing personnel to sign off on each data sheet.

3. Prepare a preliminary test report. Deficiencies will be evaluated by Architect to determine corrective action. Deficiencies shall be corrected and test repeated.

4. If it is determined that the system is constructed according to the Contract Documents, Owner will decide whether modifications required to bring the performance of the system to the OPR and BoD documents shall be implemented or if tests will be accepted as submitted. If corrective Work is performed, Owner will decide if tests shall be repeated and a revised report submitted.

END OF SECTION

# SECTION 23 09 13

# VARIABLE FREQUENCY DRIVES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Materials and installation for a complete adjustable frequency motor drive consisting of a pulse width modulated (PWM) inverter for use on a standard NEMA Design B induction motor. Design drive specifically for variable torque applications.

B. Variable Frequency Drive (VFD): Provided by Section 25 55 00.

### 1.2 QUALITY ASSURANCE

A. It is required that the drive manufacturer have an existing:
   1. Sales representative exclusively for HVAC products, with expertise in HVAC systems and controls.
   2. An independent service organization.
   3. A parts stocking depot local to the installation site.

B. Manufacturers: A firm engaged in the production of this type of equipment for a minimum of 10 years.

C. Referenced Standards:
   1. IEEE Standard 519, Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.
   2. UL 508, Industrial Control Equipment.
   3. NEMA: ICS 6, Industrial Controls and Systems Enclosures.
   4. IEC 801-2, 801-4, 255-4.

D. Testing: Test all printed circuit boards and bummed in before being assembling into the completed VFD. Subject VFD to a preliminary functional test, minimum 8-hour burn-in, and computerized final test at 104F (40C), at full rated load.

E. Qualifications:
   1. UL listed.
   2. C-UL listed or CSA approved.

### 1.3 SUBMITTALS

A. Include the following information:
   1. Outline dimensions.
   2. Weight.
   3. Typical efficiency versus speed graph for variable torque load.
   4. Compliance to IEEE 519, harmonic analysis for job site including total voltage harmonic distortion and total current distortion.
      a. Provide calculations, specific to this installation, showing total harmonic voltage distortion is less than 5 percent size. Input line filters provided as required by VFD manufacturer to ensure compliance with IEEE Standard 519.

b. Prior to installation, provide the estimated total harmonic distortion (THD) caused by the VFDs. Based results on a computer aided circuit simulation of the total actual system, with information obtained from the power provider and the user.

c. If the voltage THD exceeds 5 percent, the VFD manufacturer is to recommend the additional equipment required to reduce the voltage THD to an acceptable level.

## 1.4 WARRANTY

A. Warranty 24 months from the date of certified start-up. Include all parts, labor, travel time, and expenses.

## PART 2 - PRODUCTS

## 2.1 VARIABLE FREQUENCY DRIVES

A. Each VFD shall be configured to communicate through the local area network utilizing protocol compatible with the computerized building automation and control system, see section 255 55 00.

B. The points shown on control drawings schematic shall be hardwired.

C. All VFDs to have a complete factory wired bypass system consisting of an output contactor and bypass contactor.

D. All VFDs are provided by the BMS contractor

E. The drive manufacturer shall supply the drive and all necessary controls as herein specified. Alternate manufacturers of VFDs other than the basis of design shall be prior approved by Owner's Representative and comply fully with these specifications. Approval does not relieve supplier of specification requirements, except where request for submittal to Owner's Representative identifies specifically any variances from these specifications. Alternate manufacturers of VFDs require Owner's Representative's written approval.

F. Specific electrical requirements (i.e., horsepower and electrical characteristics, etc.) are specified within the individual equipment specification sections and as scheduled on the drawings.

G. All VFDs shall be provided by the BMS contractor unless otherwise noted on drawings. The drives shall be programmed per the specification and Sequences of Operation and start-up performed by the drive manufacturer's representative. The drive manufacturer's representative shall provide all necessary assistance to the Division 25 55 00 contractor in connecting the drive to the control network, mapping the control points, data transfer, installation and start-up commissioning.

H. Design: Solid state, with a Pulse Width Modulated (PWM) output waveform enclosed in a NEMA 1 enclosure, completely assembled and tested by manufacturer. Employ a full wave rectifier (to prevent input line notching), DC Line Reactor, capacitors, and Insulated Gate Bipolar Transistors (IGBTs) as the output switching device drive efficiency: 97 percent or better at full speed and full load. Fundamental power factor: 0.98 at all speeds and loads. Unit designed to feed two motors simultaneously.

I. Specifications:

1. Input 440/450/480/500VAC plus or minus 10 percent (capable of operation to 550VAC), 3 phase, 48 to 63Hz or Input 208/220/230/240VAC plus or minus 10 percent, 3 phase, 48 to 63Hz.
2. Output 0 - Input Voltage, 3 phase, 0 to 500Hz for drives up to 75 HP; 0 to 120Hz for drives over 75 HP.
3. Environmental Operating Conditions: 0 to 40C at 3kHz switching frequency, 0 to 3300 feet above sea level, less than 95 percent humidity, noncondensing.
4. Enclosure rated Type 1.

J. Standard Features:

1. Provide all VFDs with the same customer interface, including digital display, keypad and customer connections; regardless of horsepower rating. The keypad is to be used for local control (start/stop, forward/reverse, and speed adjust), for setting all parameters, and for stepping through the displays and menus.
2. Fault Mode on Loss of Input:
   a. Displaying a fault
   b. Running at a programmable preset speed as selected by user.
3. Utilize English digital display (code numbers are not acceptable). Digital Display: A 40 character (2 line by 20 characters/line) LCD display, backlit to provide easy viewing in any light condition, adjustable contrast to optimize viewing at any angle display. All set-up parameters, indications, faults, warnings and other information in words to allow the user to understand what is being displayed without the use of a manual or cross reference table.
4. Utilize preprogrammed application macro's specifically designed to facilitate start-up. Provide one command to reprogram all parameters and customer interfaces for a particular application to reduce programming time.
5. Automatic restart after an overcurrent, overvoltage, undervoltage, or loss of input signal protective trip. The number of restart attempts, trial time, and time between reset attempts to be programmable. If the time between reset attempts is greater than zero, the time remaining until reset occurs to count down on the display to warn an operator that a restart will occur.
6. Capable of starting into a rotating load (forward or reverse) and accelerate or decelerate to setpoint without safety tripping or component damage (flying start).
7. Automatic extended power loss ride-through circuit.
8. Customer terminal strip isolated from the line and ground: Prewired three-position Hand-Off-Auto switch and speed potentiometer. When in "Off" the VFD will be stopped. When in "Auto" the VFD will start via an external contact closure, and its speed will be controlled via an external speed reference.
9. Current Limit Circuits to Provide Trip Free Operation:
   a. Slow current regulation limit circuit adjustable to 125 percent (minimum) of the VFDs variable torque current rating. Adjustment made via the keypad, and displayed in amps.
   b. Rapid current regulation limit adjustable to 170 percent (minimum) of the VFDs variable torque current rating.
   c. Current switch off limit fixed at 255 percent (minimum, instantaneous) of the VFDs variable torque current rating.
10. Overload Rating: 110 percent of its variable torque current rating for 1 minute every 10 minutes, and 140 percent of its H torque current rating for 2 seconds every 15 seconds.
11. DC Line Reactor to reduce the harmonics to the power line.
12. Optimized for a 3 kHz carrier frequency to reduce motor noise.
13. Manual speed potentiometer or keypad as a means of controlling speed manually.

K. Adjustments:
1. Five programmable critical frequency lockout ranges.
2. PI Setpoint controller.
3. Two programmable analog inputs for reference for PI controller. Analog Inputs: include a filters; programmable from 0.01 to 10 seconds to remove any oscillation in the input signal.
4. Six programmable digital inputs for maximum flexibility in interfacing with external devices.
5. Two programmable analog outputs proportional to Frequency, Motor Speed, Output Voltage, Output Current.
6. Two independently adjustable accel and decel ramps. Ramp times adjustable from 1 to 1800 seconds.
7. The VFD to ramp or coast to a stop, as selected by user.

L. Display: The following operating information displays to be standard on the VFD digital display.
1. Output frequency.
2. Motor speed (RPM, percent or engineering units).
3. Motor current.
4. Calculated motor torque.
5. Calculated motor power.
6. Output voltage.
7. Analog input values.
8. Keypad reference values.
9. Elapsed time meter.
10. kWh meter.

M. Protection Circuits: In the case of a protective trip, stop the drive and announce the fault condition.
1. Overcurrent trip 315 percent instantaneous (225 percent RMS) of the VFDs variable torque current rating.
2. Overvoltage trip 130 percent of the VFD's rated voltage.
3. Undervoltage trip 65 percent of the VFD's rated voltage.
4. Overtemperature plus 70C (ACH 501); plus 85C (ACH 502).
5. Ground Fault either running or at start.
6. Adaptable Electronic Motor Overload (I2t).

N. Speed Command Input Via:
1. Keypad.
2. Two analog inputs, each capable of accepting a 0 to 20mA, 4 to 20mA, 0 to 10V, 2 to 10V signal. Analog inputs programmable filter to remove an oscillation of the reference signal. Minimum and maximum values (gain and offset) adjustable within the range of 0 to 20mA and 0 to 10V.

O. Accessories:
1. Door interlocked thermal magnetic circuit breaker disconnect handle, through-the-door type, and padlockable in the "Off" position.
2. Fire alarm system control interlocks for "seize control" and "on/off."
3. Two motor winding thermistor inputs to shut drive down if either motor registers overload.
4. Refer to Division 28 fire alarm drawing for connection details.
5. Fused disconnects for each motor.
6. Trouble output contact.
7. Output filter to provide for wave shaping.
8. Provide 5 percent impedance 3 phase line reactor on the input side of the VFD.

P. Manufacturers: Siemens, General Electric, Danfoss, Yaskawa, Mitsubishi, ABB, or approved.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Coordinate with installers of power and control wiring.

B. Installation shall be the responsibility of the Division 25 55 00 contractor. Install the drive in accordance with the recommendations of the VFD manufacturer as outlined in the installation manual.

C. Power wiring shall be completed by a licensed electrical contractor. The contractor shall complete all wiring in accordance with the recommendations of the VFD manufacturer as outlined in the installation manual. Existing motor contactors shall be removed from MCC and existing HOA switches shall be removed and blanked off. Existing smoke shutdown wiring shall be relocated to safety shutdown terminal strip of VFD.

### 3.2 START UP

A. Provide certified factory start-up for each drive by a factory-authorized service center. Provide a certified start-up form for each drive.

B. Test unit operation in all modes of operation.

**END OF SECTION**

# SECTION 23 21 05

# HYDRONIC PIPING SYSTEMS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Work Included: Materials, installation, and testing of:
   1. Pipes and pipe fittings for chilled water, heating water, and drain.
   2. Valves.
   3. Hydronics specialties, including the following:
      a. Manual air vent valves.
      b. Automatic air vent valves.
      c. Automatic flow control valves.
      d. Pressure independent valves.
      e. Gauges.
      f. Instrument probe fittings.

### 1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of components of types and sizes required.

### 1.3 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data, installation instructions, and dimensioned drawings for each type of pipe, pipe fitting, valve, hydronic specialty, chemical, and component.

B. Submit Piping Schedule showing manufacturer, pipe or tube weight, fitting type, and joint type for each piping system.

C. Maintenance Data: Submit maintenance data and parts list for all components. Include this data, product data, and certifications in maintenance manual.

D. Certificates of Compliance: Submit letters of certification stating that the piping as submitted per the Piping Schedule is in compliance with the standards of compliance as specified.

### 1.4 PRODUCT HANDLING

A. Provide factory applied end caps on each length of pipe and tube. Maintain end caps through shipping, storage, and handling as required to prevent pipe end damage and eliminate dirt and moisture from inside of pipe and tube.

B. Store components inside and protected from weather.

C. Where possible, store pipe and tube inside and protected from weather. Where necessary to store outside, elevate above grade and enclose with durable, weatherproof wrapping.

D. Protect flanges and fittings from moisture and dirt by inside storage and enclosure, or by packing with durable, waterproof wrapping.

## PART 2 - PRODUCTS

### 2.1 PIPE AND FITTINGS

A. General: Provide pipe, tube and fittings of the type, fitting requirements, grade, class, size and weight indicated or required for each service. Where type, grade, or class is not indicated, provide proper selection as determined by installer for installation requirements, and comply with governing regulations and industry standards. All piping in a given size range of same type.

B. Service:
1. Chilled Water (Above Grade):
   a. Pipe Sizes 2-1/2 Inches and Larger:
      1) Steel, black, Schedule 40 with welded, flanged, or grooved Victaulic.
      2) Copper tubing, Type K or L, with brazed fittings, or grooved Victaulic.
   b. Pipe Sizes 2 Inches and Smaller:
      1) Steel, black, Schedule 40 with welded or threaded fittings.
      2) Copper tubing, Type K or L, with soldered fittings (95/5 solder).
      3) Pressfit system.
2. Heating Water (Above Grade):
   a. Pipe Sizes 2-1/2 Inches and Larger:
      1) Steel, black, Schedule 40 with welded, flanged.
      2) Copper tubing, Type K or L, with brazed fittings.
   b. Pipe Sizes 2 Inches and Smaller:
      1) Steel, black, Schedule 40 with welded or threaded fittings.
      2) Copper tubing, Type K or L, with soldered fittings (95/5 solder).
      3) Pressfit system.
3. Drain Pipe:
   a. Steel, black, Schedule 40, threaded fittings.
   b. Copper tubing, M, soldered fittings (95/5 solder).

C. Steel Drain Pipe: ASTM A53, Schedule 40, Galvanized or black.

D. Copper Tube - Temper: Provide Type "K" hard drawn temper unless otherwise directed.

### 2.2 VALVES

A. General: Provide end connections which properly mate with pipe, tube and equipment connections. Where more than one type is indicated, selection is installer's option.

B. Sizes: Unless otherwise indicated, provide valves of same size as upstream pipe size.

### 2.3 MANUAL AIR VENT VALVES

A. Manufacturers: Armstrong, Bell & Gossett, Hoffman, Spirax Sarco, or approved.

B. Operated manually with screwdriver or thumbscrew, 1/8-inch NPS or 1/4-inch NPS connection as required.

## 2.4 AUTOMATIC AIR VENT VALVES

A. Manufacturers: Taco Hy-Vent, Bell & Gossett, Hoffman, or approved for branch lines. Hoffman 78 or approved at air separators, mains, in mechanical rooms.

B. Float type with pressure rating equal to or greater than the system in which it is installed.

## 2.5 AUTOMATIC FLOW CONTROL VALVES

A. General: Pressure independent design, constructed to provide constant flow over a range of differential pressures, with field adjustable control point.

B. Accuracy: Plus or minus 5 percent.

C. Flow Characteristic. Smooth, continuous curve, void of abrupt changes over the entire range of operation.

D. Construction: Brass body, EPDM O-ring seals, abrasion resistant and non-corrosive thermoplastic cartridge, 1/8-inch pressure ports.

E. Flow adjustment: External adjustment via removable key and numeric dial indicator. Indicator reading to match manufacturer's data chart for calibration and flow reading.

F. Pressure/Temperature Rating: 230 PSIG/248F.

G. Manufacturer: Griswold Flowcon SH or approved.

## 2.6 STRAINERS

A. Manufacturers: Mueller, Armstrong, Keckley, Hoffman, Hayward, Wheatley, or approved.

B. General: Full line size strainers with ends matching connecting piping materials, machined screen seats, gasketed cap, blow off outlet, minimum 2-1/2 to 1 open area ratio, and Type 304 stainless steel screens with 1/16-inch diameter holes.

C. Y-Strainers:
1. Copper Pipe Installations: Mueller 352-1/2.
2. Steel Pipe Installations: Mueller 11.

## 2.7 THERMOMETERS

A. Manufacturers: Ashcroft, Trerice, Weiss, Palmer, Marshaltown, Weksler, or approved.

B. 3-inch diameter bimetal dial thermometer, stainless steel case, white dial, black numbers, 4-inch stainless steel stem, brass separable socket. Back or bottom connections as required.

| Service | Range |
|---|---|
| Heating Water | 50 to 300F |
| Chilled Water | 0 to 120F |
| Condenser Water | 50 to 150F |

## 2.8 THERMOMETER WELLS

A. Manufacturers: Same as thermometers.

B. Brass or stainless steel, pressure rated to match piping system design pressure. Provide extensions for insulated piping of length required to extend above insulation used at each location. Provide cap nut with chain fastened permanently to thermometer well.

## 2.9 PRESSURE GAUGES

A. Manufacturers: Amtek/U.S. Gauge, Ashcroft, Palmer, Marshaltown Instruments, Trerice, Weiss, Weksler, or approved.

B. Type: General use, 1 percent accuracy, ANSI B40.1, Grade A, phosphor bronze bourdon type, bottom connection.

C. Case: Drawn steel or brass, glass lens, 4-1/2-inch diameter.

D. Connector: Brass with 1/4-inch male NPT.

E. Scale: White coated aluminum, with permanently etched markings.

F. Range:
1. Pump Suctions: 30-inch Hg - 60 PSI.
2. Water: 0 - 100 PSI.

## 2.10 INSTRUMENT PROBE FITTINGS

A. Manufacturers: Pete's Plug, or approved.

B. Brass or stainless steel body and cap, high pressure rated, valve material neoprene, Nordal or Viton to suit temperature range, 1/4 inch or 1/2-inch NPT tailpiece.

## 2.11 EXPANSION JOINTS

A. Manufacturers: Flexonics, Mason Industries, Amber-Bush, Metraflex, or approved.

B. Furnish and install controlled flexing expansion joints where shown or required. Expansion Joints: Minimum of 150 PSI working pressure.

C. For copper piping, 3/4 inch through 3 inches, use Type HB, 1-3/4-inch traverse two-ply stainless steel bellows, traveling nipple extended through bellows and guided each end, integral shroud, screwed steel ends.

D. For steel piping, 1-1/2 inches through 8 inches externally pressurized. 4-inch traverse, 150 PSI working pressure, stainless steel bellows, 150 PSI flanged ends, furnish insulation shroud.

## 2.12 PIPE GUIDES

A. Manufacturers: Flexonics "Flexon," Mason Industries, Amber-Bush, Metraflex, or approved.

## 2.13 PIPE ANCHORS

A. Manufacturers: Flexonics, Mason Industries, Amber-Bush, Metraflex, or approved.

## 2.14 ACCESS PANELS

A. Provide flush mounting access panels as required for service of fire dampers, cleanouts, valves, and the like, and other items requiring maintenance or inspection. Where access panels are located in fire-rated assemblies of building, rate access panels accordingly. Ceiling access panels to be minimum 24x24 (or required and approved size). Wall access panels to be minimum 12x12 (or required and approved size).

B. Manufacturers: Milcor, Karp, Elmdor, In-Ryko, Acudor, or approved. Provide two keys for each set of locks provided.

## PART 3 - EXECUTION

## 3.1 HYDRONICS SPECIALTIES INSTALLATION

A. Manual Vent Valves: Install on each hydronic terminal at highest point, and on each hydronic piping drop in direction of flow for mains, branches, and runouts, and elsewhere as indicated. Provide manual vents of 1/8 inch in size in pipes through 2 inches in diameter, and vents of 1/4 inch size in pipes 2-1/2 inches and larger.

B. Installation of Temperature Gauges:
1. Install in vertical upright position, tilted so as to be easily read at floor.
2. Glass Thermometers: Install at the following locations, and elsewhere as indicated: At inlet and outlet of each hydronic coil.
3. Thermometer Wells: Install in piping in vertical upright position. Fill well with oil or graphite, secure cap.

C. Installation of Pressure Gauges:
1. General: Install pressure gauges in piping tee with pressure gauge cock, located on pipe at most readable position.
2. Locations: Install in the following locations, and elsewhere as indicated:
   a. Provide at inlet and outlet of each hydronic coil.

D. Expansion Joints: Provide where required to allow pipe expansion due to thermal stresses. Provide locations per manufacturer's recommendations. Provide a pipe guide on each side of each expansion joint, located per manufacturer's recommendations. Provide guides in addition to all other pipe supports and hangers. Do not use guides in lieu of supports or hangers required per Section 23 05 29, Hangers and Supports for HVAC Piping and Equipment.

## 3.2 AIR VENTS

A. Automatic: Furnish and install automatic air vents at all high points of the water systems and as otherwise required. Vents: 3/4 inch with 1/2-inch IPS drain piping to the nearest floor drain or other approved location. Provide a gate valve and union ahead of all automatic air vents.

B. Manual Vents (Where no Floor Drain or other Acceptable Location Exists): Provide 10-inch length of 1/4-inch copper tube with 180 degree bend down to discharge into hand-held bucket.

## 3.3 GAUGE ADJUSTING AND CLEANING

A. Adjust faces of meters and gauges to proper angle for best visibility.

B. Clean windows of meters and gauges and factory finished surfaces. Replace cracked or broken windows, repair any scratched or marred surfaces with manufacturer's touch-up paint.

## 3.4 PIPE TEST

A. General:
1. Make all tests in presence of Architect or authorized representative.
2. Make test before pipes are concealed.
3. Fill system and remove air from system at least 24 hours before test begins.
4. Correct leaks in screwed fittings by remaking the joint. Cut out and reweld leaks in welded joints; caulking is not permitted.

B. Water Piping: Apply test pressure 125 PSI and maintain for 1 hour with no visible leaks and no appreciable drops after the test pump has been disconnected.

## 3.5 PIPE GUIDES

A. Install on continuous runs where pipe alignment must be maintained. Minimum two on each side of expansion joints, spaced per manufacturer's recommendations for pipe size. Fasten guides to pipe structure. Contact with chilled water pipe not to permit heat to be transferred in sufficient quantity to cause condensation on any surface.

B. Install approximately 4 pipe diameters (first guide) and 14 diameters (second guide) away from each end of all expansion joints. Do not use as supports. Provide in addition to other required pipe hangers and supports.

## 3.6 PIPE ANCHORS

A. Furnish and install pipe anchors where shown or required to prevent pipe movement. If fabricated, construct anchors of steel plate, 3/4-inch minimum thickness, securely welded to pipe with two steel plates, stiffeners and bolted to structure.

## 3.7 ACCESS PANELS

A. Install ceiling or wall access panels to provide access to concealed valves, fans, motors, fire dampers, terminal units, coils and other items needing service. Provide access panels at locations required or as specified herein. Coordinate locations/sizes of access panels with Architect prior to work.

**END OF SECTION**

# SECTION 23 31 00

# DUCTWORK

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Materials, installation and testing of HVAC ductwork and accessories, including the following:
   1. Heating and air conditioning supply and return systems.
   2. Outside air systems.
   3. Exhaust systems.
   4. Ductwork hangers.
   5. Plenums.

### 1.2 QUALITY ASSURANCE

A. Unless otherwise noted, where the Specification refers to SMACNA in reference to sheet metal or flexible ductwork, this refers to HVAC Duct Construction Standards, Metal and Flexible, latest edition, as published by SMACNA.

B. Unless otherwise noted, where the Specification refers to TIMA in reference to fiberglass ductwork, this refers to Fibrous Glass Duct Construction Standards, latest edition, as published by TIMA.

C. Provide duct systems per CMC, latest edition, and all referenced standards.

D. Have available at the project field office a copy of the referenced standards.

### 1.3 SUBMITTALS

A. Provide shop drawings for duct materials, flues.

B. Submit duct pressure testing reports. Provide individual reports for each AHU duct system.

### 1.4 AIR DISTRIBUTION DUCT SYSTEM

A. General: All ductwork, including collars, register boxes, fire dampers, exhaust fans, ventilation louvers, roof vents and screens, as well as all dampers and any other miscellaneous items not specifically mentioned but necessary for a complete installation. Apply the latest standards of SMACNA and ASHRAE with respect to sheet-metal gauge and general construction for round and rectangular ducts.

## PART 2 - PRODUCTS

### 2.1 GALVANIZED SHEET-METAL DUCTWORK

A. General: CMC Duct Construction Standards, latest edition, or latest edition of ASHRAE Guide Table. G90 Steel.

## 2.2 FLEXIBLE DUCTS

A. General: Comply with CMC, latest edition, Class 0 or Class 1.

B. Standard factory fabricated product, construct an inner wall of impervious vinyl or chlorinated polyethylene, permanently bonded to a vinyl or zinc-coated spring steel helix. Cover the assembly with fiberglass blanket insulation covered by an outer wall of vinyl or fiberglass-reinforced metalized vapor barrier. UL 181 listed Class 1 flexible air duct material. Overall thermal transmission no more than 0.25 (BTU/in)/(hr/sq.ft./deg. F) at 75F differential, per ASTM C335. Vapor transmission value no more than 0.10 perm, per ASTM E96. Rated for a minimum of 4-inch w.g. positive pressure and 1-inch w.g. negative pressure.

C. Air friction correction factor of 1.3 maximum at 1000 FPM. Working air velocity of at least 2000 FPM. Flame spread rating no more than 25. Smoke development rating no more than 50 as tested per ASTM E84. Must have cataloged data on insertion loss characteristics, minimum attenuation of 29 DB for 10-foot straight length at 8-inch diameter and 500 Hz.

D. Manufacturers: J. P. Lamborn Co., Norflex, Clevaflex, Genflex, Atco, Flexmaster, Thermaflex, or approved.

## 2.3 FACTORY FABRICATED METAL ROUND AND FLAT OVAL DUCTWORK

A. General: Provide per CMC Duct Construction Standards, latest edition, and ASTM A527 Class 0. Round sheet metal, spiral lock seam type. Fittings: Same construction as the duct. Tap in fittings not allowed. Duct sealer: Specifically formulated for sealing field joints for round spiral lock-seam duct systems.

## 2.4 SHEET-METAL DUCT SEALER

A. Hardcast "Duct-Seal 321" or United McGill. Indoor/outdoor, low VOC (<20 GPL), water based with fiber reinforcement.

## 2.5 PREFABRICATED DUCT JOINTS

A. Manufactured flanged traverse rectangular and round duct joints.

B. Manufacturers: Ductmate, Mez, Ward Duct Connectors, Lockformer TDC, or approved.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. The duct layout shown on the Contract Drawings is diagrammatic in nature. Coordinate the ductwork routing and layout, and make alterations to the ductwork routing and layout as required to eliminate physical interferences. Where deviations in the ductwork routing as shown in the Contract Drawings are required, such alterations not to compromise the air flow, pressure drop, and sound characteristics of the duct fitting or run as shown on the Contract Drawings. Make such determination by Architect. In the event Architect determines that the installed ductwork is inconsistent with the above mentioned criteria, remove and replace at no additional cost to the Owner.

B. Install ductwork in the location and manner shown and detailed. Review deviations required by job conditions with Architect prior to any fabrication. Provide fittings construction per SMACNA.

C. Connect duct assemblies such as ductwork, plenums, etc., and operating machines or mechanisms such as fans, air conditioners, etc., with flexible connections per Section 23 05 48, Vibration and Seismic Controls for HVAC Piping and Equipment.

D. Fabricate radius elbows with centerline radius not less than 1-1/2 duct diameters.

E. Do not install duct size transition pitch angles which exceed 30 degrees for reductions in duct size in the direction of airflow, and 15 degrees for expansions in duct size in the direction of airflow.

F. Install single thickness turning vanes in square throat rectangular elbows and in tees. Provide 3/4-inch trailing edge on turning vanes, turned slightly past parallel to the duct.

G. Duct sizes indicated are free inside dimensions including where internal lining is shown.

H. Provide galvanized sheet-metal duct material for all ducts unless otherwise indicated or specified.

I. Provide temporary closures of open ducts during construction to prevent dust and debris from entering the system.

J. Flexible Duct:
1. Install flexible duct with bend radius equal to 1.5 times the diameter. Minimum length 2 feet. Maximum length 5 feet, unless noted otherwise.
2. Provide round neck grilles/diffusers or square-to-round transitions. No flex duct connections directly to square neck allowed.
3. Flex duct allowed only for vertical drops to diffusers. Maximum offset angle from vertical: 30 degrees.
4. Approved for use on supply ducts only; not allowed for return or exhaust.
5. Flex duct allowed in concealed spaces above lay-in ceilings only.

K. Fabricate ductwork and all sheet metal work of prime grade, lock forming quality steel in accordance with the current issues of the ASHRAE "Guide" and SMACNA standards and installed in strict conformance with SMACNA standards.

L. Submit shop drawings for approval for all ductwork. All ductwork to be sheet metal.

M. Construct ductwork upstream of VAV boxes for 4-inch pressure class; downstream duct 1-inch pressure class. All other duct 2-inch pressure class.

N. Round spiral duct and fittings or where required due to available clearances, use flat oval ductwork and fittings upstream of terminal units manufactured by United Sheet Metal, Rolok or approved in accordance with ASTM A527.

O. Seal all joints and seams in supply, exhaust, and return air ductwork and plenums.

P. Fabricate ductwork and plenums with a smooth inside surface and support and brace to prevent sagging and vibration at any time. Provide galvanized steel angles for reinforcing and bracing.

Q. Joints:

1. Carefully cut and trim all joints and seams in fabricated ducts and fitting to form a closed joint with no portion of the duct or fitting protruding into the air stream.
2. Seal all joints in sheet-metal ducts in concealed locations (such as enclosed ceiling spaces) with Hardcast joint sealant system applied in accordance with manufacturer's recommendations, or use Ductmate-type joints.
3. Seal all joints in sheet-metal ducts in exposed locations with sealant system applied in accordance with manufacturer's recommendations. Wipe off excess sealer on duct to give a clean finish, or use Ductmate-type joints.
4. Standard gray duct tape not allowed.

R. All fasteners such as sheet-metal screws, machine screws or rivets to be cadmium plated.

S. Crimp flat duct surfaces diagonally or beaded regardless of size, unless acoustically lined.

T. Fabricate all duct size transitions with a slope of not more than 1 foot to 5 feet where possible, but in no case more than 1 foot in 3 feet.

U. Fabricate duct turns with the inside (smallest) radius at least equal to the duct width. Where necessary, square elbows may be used, with maximum available inside radius and with fixed single thickness curved vanes, with trailing edge extended 3/4 inch.

V. Provide flexible connectors at connections to all equipment, in ducts crossing building expansion joints and may be used at connections of dissimilar metals. Flexible Connections: Minimum 16 ounce airtight "Ventglass" noncombustible fabric with fire retardant neoprene coating on outside, fastened with bolted galvanized steel bands. Maintain a minimum 1-inch space between the connecting surfaces.

W. Duct Hangers and Supports:

1. Hang rectangular sheet-metal ducts with a cross sectional area of less than 7 sq.ft. with galvanized strips of No. 16 USS gauge steel 1 inch wide, and all larger ducts with steel angles and adjustable hanger rods similar to piping hangers. Support at 8 feet on center, as detailed, or per SMACNA.
2. Anchor all ducts securely to building in such a manner as to prevent transmission of vibration to structure. Do not connect duct hanger straps to roof deck. Do not support ducts from other ducts or piping.
3. For round sheet-metal ducts, provide duct support in accordance with SMACNA Guidelines. Verify type of building construction.
4. Attach strap hangers installed flush with end of sheet-metal duct run to duct with sheet-metal screws.
5. Seismic Restraint: Brace all ductwork against lateral movement as detailed in document "Seismic Restraint Manual Guidelines for Mechanical Systems" as published by SMACNA.

X. Ductwork not to be supported from the roof deck. Hang ducts from beams, joists or supplementary structural members. Do not hang ductwork from joist bridging or from other ducts. Ductwork can be supported from the roof deck if approved by the structural engineer.

Y. Although not necessarily indicated on the Drawings, provide turning vanes at all mitered elbows, opposed blade balancing dampers with locking quadrants at branch ducts, volume extractors and any other applicable devices necessary for minimum duct resistance and proper system air balancing. Sufficiently stiffen all dampers to prevent noise or vibration and in no case be lighter than 20 gauge steel. Provide with accessibly located adjuster, manufactured by Young Regulator Co., Parker Kalon Corporation, or approved.

Z. Construct all exterior ductwork or ductwork which is otherwise exposed to weather watertight.

AA. Increase the size of all sheet-metal ducts as required to accommodate insulation lining.

BB. Locate access doors in ductwork as required for service of fire dampers, automatic dampers and other items requiring maintenance or inspection.

CC. Paint inside surface of all bare ductwork which is visible through face of grilles with flat black paint.

## 3.2 DUCTWORK PRESSURE TESTING

A. Leak test pressure classes per SMACNA.

B. Provide air pressure testing of concealed ductwork systems (testing is not required for ductwork exposed to air conditioned space). Test ductwork prior to connection to fan equipment. Repair leaks and retest until stipulated results are achieved.
1. Test at positive static pressure for 5 minutes with maximum air leakage not to exceed 1 percent of rated flow.
2. Testing machine: Meet requirements of SMACNA standards. Pacific Air Products "Port-O-Lab," Rolok, United Sheet Metal, or approved.
3. Test supply systems prior to connecting VAV boxes.
4. Perform all tests in the presence of Owner's Representative. Give 48 hours advance notice before commencement of each test.
5. Test ductwork systems in sections as large as possible and record all test results according.
6. Coordinate testing with ceiling installation.
   a. Provide sheet-metal plates and install between each duct test section (applies to main-to-main fittings, branch-to-branch fittings and main-to-branch fittings). At each plate location, fabricate joint with Ductmate. Insert 14 gauge sheet metal between Ductmate using a neoprene gasket on both sides of metal plate.
   b. Leave plates in place until isolated section has been tested and approved by Owner's Representative.
   c. Once sections have passed test, remove plates and reattach Ductmate joints. After fan unit is running, test joint for leakage by using a mixture of soap and water. If any noise or bubbling occurs, reseal joint. Owner's representative to witness this procedure.
7. Test duct at 1-1/2 times the design air pressure. Seal any audible leaks.

## 3.3 MOUNTING FOR SIDEWALL GRILLES AND REGISTERS

A. All mounting heights indicated on Drawings from finish floor to lower edge of grille or register. Exception: If note on Drawings states for example "Down 6 inches," this indicates measurement from ceiling to top edge of grille or register.

B. Install all sidewall return air grilles for "sight-tight" visibility at eye level (position blades to obscure visibility from floor level).

## 3.4 GRILLE AND EXPOSED DUCT CLEANING

A. After completion of ductwork installation, operate each fan system (excluding exhaust fans) for a minimum of 30 minutes prior to installation of ceiling grilles and diffusers. After grilles and diffusers are installed, clean out all accumulation of particles from grilles and diffusers prior to acceptance.

B. Clean exterior surface of all ducts exposed to public view of chalk, pencil and pen marks, labels, sizing tags, dirt, dust, etc., so that upon completion of installation, ducts are left in clean and unblemished manufactured condition.

C. All exposed duct and grilles shall remain free of dust entrained streaks due to leakage at joints and grille connections during warranty period. Clean leaks, seal and refinish to match existing if visible streaks develop.

**END OF SECTION**

# SECTION 23 33 00

# DUCTWORK ACCESSORIES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Work Included: Materials, installation, and testing of HVAC duct accessories such as volume dampers, splitter dampers, adjustable deflectors, duct access doors, backdraft dampers, fire dampers, duct silencers, spin-in fittings, and smoke dampers.

### 1.2 QUALITY ASSURANCE

A. Provide fire dampers in conformance with the requirements of Fire Damper and Heat Stop Guide for Air Handling Systems, as published by SMACNA.

### 1.3 SUBMITTALS

A. Submit manufacturer's catalog data and fabrication/installation drawings for each factory fabricated duct accessory.

## PART 2 - PRODUCTS

### 2.1 DAMPERS

A. Volume Dampers (VD):
   1. Construct of galvanized sheets not lighter than 18 gauge, reinforced to prevent vibration, equipped at both ends with brass bearing mounts and of sufficient length to provide a complete shutoff of the duct.
   2. Provide each damper with an adjustment and locking quadrant device manufactured by Young Regulator Co., No. 403 operator for accessible locations, or No. 315 for nonaccessible locations. Ventlock, or approved. Provide operating rod and attaching devices as required for No. 315 operator. Provide Young Regulator No. 443 or 443B raised platform for insulated duct.

B. Register Dampers: Dampers utilized with grilles. Opposed blade dampers utilizing a side operated worm drive which provides external duct operation. Slot the end of the shaft to receive a screwdriver. Factory assembled side operator. Construct of the same material as the grille. Manufacturers: Same as grilles and diffusers. Provide Young Regulator 443 or 443B raised platform for insulated duct.

C. Control Dampers: Provide automatic control dampers as indicated. Airfoil, multiblade type, maximum blade length of 48 inches. Provide parallel blades for positive or modulating mixing service and opposed blades for throttling service. Blades to be interlocking, minimum 16 gauge galvanized steel. Damper blades reinforced, have continuous full length axle shafts and/or operating jackshafts as required to provide coordinated tracking of blades. Dampers over 25 sq.ft. in area to be in two or more sections, with interconnecting blades. Dampers to have a maximum air leakage of 15 CFM psf at 4-inch w.g. pressure. Provide automatic dampers except those specified with units. Manufacturers: Louvers & Dampers, Ruskin, Cesco, Greenheck, Prefco, or approved.

## 2.2 FIRE DAMPERS

A. Manufacturers: Advanced Air, Air Balance, Inc., Cesco, C&S Air Products, Pottorff, Dowco, Greenheck, Krueger, Metalaire, Nailor Industries, National Controlled Air, Phillips, Prefco, Price Co., Ruskin, Safe-Air, Tuttle & Bailey, Ultra-Safe, United Spiral, or approved.

B. Provide with sleeves where shown and as required in accordance with NFPA 90 and local code, complete with damper blades, heat sensor, linkage and stops. Dynamic type. UL listed dampers and have near 100 percent free area.

C. For ceiling diffusers in fire-rated areas, provide a ceiling fire damper with radiation shield. Rate fusible link at 212F.

## 2.3 FIRE/SMOKE DAMPER (VERTICAL)

A. Manufacturers: Advanced Air, Air Balance, Inc., Cesco, C&S Air Products, Pottorff, Dowco, Greenheck, Krueger, Metalaire, Nailor Industries, National Controlled Air, Phillips, Prefco, Price Co., Ruskin, Safe-Air, Tuttle & Bailey, Ultra-Safe, United Spiral, or approved.

B. Motorized fire/smoke damper with motor. 22 gauge roll from galvanized steel with a 120VAC motor for motorized operation. Standard UL 212F fusible link. Provide smoke detector at each damper per code. Dynamic type. The fire dampers to be U.S. standard for 1-1/2 hour listing. Motors to be UL listed. Provide the thermal protection via the fusible link. Damper to be normally closed. Minimum leakage Class II damper. Provide with automatic reset. 250F temperature rating. Damper to fail closed when power is interrupted to actuator. Provide switch package to include two-position indicator switch linked directly to the damper blade to provide the capability of remotely indicating damper blade position.

## 2.4 FIRE/SMOKE DAMPER (HORIZONTAL)

A. Manufacturers: Advanced Air, Air Balance, Inc., Cesco, C&S Air Products, Pottorff, Dowco, Greenheck, Krueger, Metalaire, Nailor Industries, National Controlled Air, Phillips, Prefco, Price Co., Ruskin, Safe-Air, Tuttle & Bailey, Ultra-Safe, United Spiral, or approved.

B. Motorized fire damper with motor, dynamic type, 20 gauge roll from galvanized steel blades with a minimum 16 gauge steel frame and 120VAC motor for motorized operation. Standard UL 212F fusible link. Provide smoke detector at each damper per code The fire dampers to be U.S. Standard for 1-1/2 hour listing and classified by UL as a "corridor damper." Motors to be UL listed. Provide the thermal protection via the fusible link. Provide with automatic reset. Blade edge and jamb seals to be low friction type, nondegradable steel, and withstand 850F with a leakage rating of UL 555S Class II. Damper to fail closed when power is interrupted to actuator. Provide switch package to include two-position indicator switch linked directly to the damper blade to provide the capability of remotely indicating damper blade position.

## 2.5 FIRE/SMOKE DAMPER (FRONT ACCESS, OUT OF WALL)

A. Manufacturer: Ruskin, Greenheck, or equal.

B. Motorized fire/smoke damper, low leakage, dynamic type, with motor (actuator). Designed for supply/return/exhaust ducts with grille outlets. Through-the-grille access to

the damper, actuator and heat-actuated components meet IBC, NFPA 90A, NFPA 92A requirement for fire/smoke dampers near 100 percent free area with motor in airstream. Provide multiple sections where listed duct size exceeds manufacturer's largest standard size.

C. 16 gauge galvanized steel frame; 14 gauge galvanized steel airfoil blades. Silicone rubber blade edge seals. Stainless steel jamb seals.

D. Sleeve: 20 gauge galvanized steel, front flange for grille mounting integral access cabinet

E. 120VAC/60Hz motor for motorized operation. Verify and coordinate motor voltage requirements with Division 26.

F. The fire damper to be UL classified and labeled as minimum 1-1/2 hour fire damper. Actuator to be UL listed.

G. Damper: Minimum UL555S leakage Class I, 350F temperature rating.

H. Provide heat-actuated release device, 212F, which permit controlled closure through the actuator and are automatic remote resettable after test, smoke detection or power failure conditions.

I. Near 100 percent free area (excluding motor). Dampers blocking airflow with separate motor compartment not acceptable unless open area is selected to match duct size.

J. Provide switch package to include two-position indicator switch linked directly to the damper blade to provide the capability of remotely indicating damper blade position. Provide switch package to include two-position indicator switch linked directly to the damper blade to provide the capability of remotely indicating damper blade position.

## 2.6 SMOKE DAMPER

A. SD smoke dampers meeting or exceeding the following specifications. Minimum of 0.125-inch aluminum frame. Stainless steel bearings. Airfoil blades. Silicone rubber blade edge seals designed to withstand 450F and of aluminum flexible metal compression seals. Blade action to be parallel blade or opposed. UL rated damper for use in smoke control systems under the latest version of UL 555S, and bear a UL label. The leakage rating under UL 555S to be leakage Class 1 (4 CFM/ft. at 1-inch w.g.). As part of the UL qualification, dampers to have demonstrated a capacity to operate (to open and close) under HVAC system operating conditions with pressures of at least 4-inch w.g. in the closed position, and 400 fpm air velocity in the open position.

B. In addition to the leakage ratings already specified herein, quality the smoke dampers and their operators under UL 555S to an elevated temperature of 250F. Install appropriate electric operators by damper manufacturer. Supply damper and operator as a single entity which meets UL 555S for both dampers and operators. Provide switch package to include two-position indicator switch linked directly to the damper blade to provide the capability of remotely indicating damper blade position.

## 2.7 DUCT ACCESS DOORS

A. Gasketed, hinged or removable, rated for operating pressure. Ductmate "Sandwich" for rectangular ductwork or "Metu" for round ductwork, or approved.

## PART 3 - EXECUTION

### 3.1 VOLUME DAMPERS

A. Provide in main duct branches where shown. Provide in branch ducts serving air inlets and outlets.

B. Locate dampers as close to trunk or main branch as possible.

### 3.2 FIRE DAMPERS

A. Install in accordance with SMACNA, the manufacturer's recommendations, UL 555, and NFPA 90A.

B. Install where indicated on the Drawings.

### 3.3 FIRE/SMOKE DAMPERS AND SMOKE DAMPERS

A. Install dampers per manufacturer's instructions.

B. If damper is installed within a duct, provide smoke detector within 5 feet of damper with no air inlets or outlets between the damper and detector. Detector to be listed for air velocity, temperature and humidity anticipated at point of installation.

C. If damper is installed within an unducted opening, provide smoke detector located within a 5-foot horizontal radius of the damper to control the damper.

D. Provide control wiring, transformers and power connections for an operable damper and detection system.

### 3.4 DUCT ACCESS DOORS

A. Install where shown and required by SMACNA. Provide on the reset side of all fire dampers and adjacent to duct mounted automatic dampers. Install per manufacturer's recommendations.

B. Where access doors are for service of fire or smoke dampers, provide indicator on the outside of the door.

**END OF SECTION**

# SECTION 23 34 00

# FANS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Work Included: Materials, installation, and testing of fans used for ventilation and exhaust service.

### 1.2 SUBMITTALS

A. Submit manufacturer's catalog data, fan curves with operating points indicated, spare parts list, operation and maintenance manuals, and test reports for each type and size of fan.

B. Submit sound power levels for fan inlet and outlet at operation points.

## PART 2 - PRODUCTS

### 2.1 CENTRIFUGAL BELT DRIVE ROOF EXHAUST FANS

A. Hood Construction: Aluminum dome, hingeable for service.

B. Fan and Inlet Cone: Aluminum, centrifugal blower type. Wheels overlap the spun venturi. Wheels statically and dynamically balanced.

C. Motors: Permanently lubricated, sealed ball bearings.

D. Wheel Shaft: Ground and polished steel and mounted in permanently lubricated, sealed pillow block ball bearings.

E. Drives: Sized for a minimum of 165 percent of driven horsepower.

F. Pulleys: Fully machined cast iron, keyed and enclosed to the wheel and motor shafts.

G. Motor Pulley: Adjustable for final system balancing. Mount the entire drive assembly on vibration isolators.

H. AMCA Certified Ratings Seal for both air and sound.

I. Manufacturers: Greenheck, Carnes, Cook, Penn, ILG, Breidert, Acme, JencoFan, or approved.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Secure fans to curb with lag bolts on each side. Seal with mastic. Mount level.

**END OF SECTION**

# SECTION 23 36 00

# AIR TERMINAL UNITS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Work Included: Materials, installation and testing for variable air volume terminal units, including the following:
   1. Central Air Terminals:
      a. Shutoff.
      b. Reheat.

### 1.2 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. ARI Compliance: Provide air terminals which have been tested and rated in accordance with ARI 880-98, Air Terminals, and bear ARI certification seal.
   2. NFPA Compliance: Construct air terminals using acoustical and thermal insulations complying with NFPA 90A, Air Conditioning and Ventilating Systems.

### 1.3 SUBMITTALS

A. Product Data: Manufacturer's technical product data, including performance data for each size and type of air terminal furnished.

B. Schedule: Showing drawing designations, room locations, number furnished, model number, size, and accessories furnished.

C. Shop Drawings: Manufacturer's assembly type shop drawings, indicating dimensions, weight loadings, required clearances, and methods of assembly of components.

D. Sound Levels:
   1. Radiated and discharge sound power levels at octave bands 2 to 6 minimum, full range of rated inlet static pressure for each terminal size and required airflow; per ARI 880.
   2. NC levels based on 10Db room effect, 10Db ceiling transmission loss and 1-1/2-inch inlet static pressure for each terminal size and required air flow; per ARI 880.

E. Selection: Do not select units outside the range of manufacturer's cataloged data for capacity scheduled. Units to be selected and provided with a maximum inlet velocity of 200 FPM. Provide units with a 1800 to 2000 FPM inlet velocity range.

## PART 2 - PRODUCTS

### 2.1 TERMINAL UNITS WITH HOT WATER HEAT

A. General: Furnish and install shutoff-type variable air volume units as herein specified. Provide units with hot water heating coils as scheduled.

B. Casing:
   1. Factory assembled, manufactured of corrosion protected welded steel and fabricated to withstand the pressures encountered. 22 gauge minimum casing.
   2. Maximum Unit Height: 18 inches.
   3. Inlet: Round or oval to match standard duct sizes.
   4. Casing acoustically and thermally insulated with 1-1/2 lbs./cu.ft. density. Insulation UL listed and approved for UL 181. The insulation to meet NFPA 90A requirements. Thickness: 1/2 inch minimum. Construct units with solid inner liner over insulation.

C. Air Modulation Device: Accomplish air volume control at the unit inlet by a normally open air valve or heavy duty damper. Modulate from full airflow to scheduled minimum air flow as indicated. Device capable of tight shutoff. Maximum leakage rate across the air throttling device: 3 percent of design air flow at 4-inch static pressure, 3-inch differential. Actuator compatible with linkage.

D. Flow Sensor: Provide an integral flow ring sensor or other averaging type calibration device along with unit mounted calibration chart to ensure accuracy of airflow measurement of plus or minus 5 percent under all types of inlet conditions. Single point sensing tap will not be acceptable. Flow maximums and minimums as shown on Drawings.

E. Acoustics: Radiated NC level based on ARI 880 not to exceed that specified based on 8Db room effect and 10Db ceiling transmission loss and 1-1/2-inch inlet static pressure.

F. Hot Water Reheat Coil: Provide terminal units with hot water reheat coil where specified, performance as shown on Drawings. High temperature drop coil. 5/8-inch OD seamless copper tubes mechanically expanded to aluminum fins. 150 PSIG working pressure. Sweat connections.

G. Controls: Supplied by control manufacturer; direct digital control. Coordinate with Contractor.

H. Manufacturers: Trane, Titus, Tuttle & Bailey, Krueger, Price, Carrier, Environmental Technology, Carnes, Enviro-Tech, Air Devices, Nailor-Hart, Redd-I, Tempmaster, or approved.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. General: Install air terminals in accordance with manufacturer's installation instructions.

B. Location: Install each unit level and accurately in position indicated in relation to other work; and maintain sufficient clearance for normal service and maintenance, but in no case less than that recommended by manufacturer.

C. Duct Connections: Connect ductwork to air terminals as indicated.

## 3.2 FIELD QUALITY CONTROL

A. Upon completion of installation and prior to initial operation, test and demonstrate that air terminals and duct connection to air terminals are leaktight. Repair or replace air terminals and duct connections as required to eliminate leaks, and retest to demonstrate compliance.

**END OF SECTION**

# SECTION 23 37 00

# AIR OUTLETS AND INLETS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Work Included: Materials, installation, and testing of HVAC outlets and inlets.

### 1.2 QUALITY ASSURANCE

A. Components: Tested, rated and certified per Air Diffusion Council procedures.

B. Air Movement and Control Association Int'l (AMCA) Compliance: Test and rate louvers in accordance with AMCA 500, "Test Method for Louvers, Dampers and Shutters." Provide louvers bearing AMCA Certified Rating Seal.

### 1.3 SUBMITTALS

A. Manufacturer's catalog data on each of the following:
   1. Type of register, diffuser, grille, frame, louver, and dampers.
   2. Schedule of air outlets and inlets indicating drawing designation, model number and accessories furnished.

## PART 2 - PRODUCTS

### 2.1 GRILLES, REGISTERS, DIFFUSERS

A. Subject to compliance with requirements, provide products of one of the following.

B. Provide 1-, 2-, 3-, or 4-way deflection as indicated.

C. Register Dampers: Dampers utilized with grilles. Opposed blade dampers utilizing a side operated worm drive which provides external duct operation. Slot the end of the shaft to receive a screwdriver. Factory assembled side operator. Construct of the same material as the grille. Manufacturers: Same as grilles and diffusers.

D. Coordinate mounting frames with construction types per finish schedule.

E. Performance: Provide components that have velocity, throw and drop, and noise criteria ratings for each size device as listed in manufacturer's current standard literature, which are plus or minus 10 percent of the components as listed in the Diffuser, Register and Grille Schedule, or as specified herein.

F. Manufacturers: Agitaire, Air Concepts, Anemostat, Carnes, Connor, Environmental Air Products, Hart & Cooley, J&J Register, Krueger, Metalaire, Nailor, Price Co, Shoemaker, Titus, Tuttle & Bailey, Seiho.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install grilles, registers, and diffusers per manufacturer's instructions. Locate and size openings through finished surfaces to provide complete coverage of rough openings by integral device flanges or auxiliary frames.

B. Paint exterior of devices per color selected by Architect.

C. Coordinate duct connections with device final dimensions. Provide square to round adapters where required for connection to round ducts.

D. Adjust the throws of air outlets to eliminate drafts.

**END OF SECTION**

# SECTION 23 62 00

# REFRIGERATION

## PART 1 - GENERAL

### 1.01 SUMMARY

A. Work Included: Materials, installation and testing of refrigeration devices for air conditioning applications.

### 1.02 SUBMITTALS

A. Submit For:
1. Air-cooled condensing unit.
2. Direct expansion cooling coil.
3. Written listing of refrigerant pipes with pipe sizes per condensing unit manufacturer's recommendations.

### 1.03 DELIVERY, STORAGE AND HANDLING

A. Handle equipment and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged chillers or components; replace with new.

B. Comply with manufacturer's rigging and installation instructions for unloading centrifugal chillers and moving them to final location.

### 1.04 WARRANTY

A. Air conditioning compressors, 5 ton and smaller, to have an additional 4 year warranty covering parts only.

B. Replace parts proving defective during the warranty period, including the replacement of lost refrigerant and repair of leaks, to the acceptance by Architect and at no additional cost to the Owner.

## PART 2 - PRODUCTS

### 2.01 REFRIGERANT PIPING

A. Size refrigerant piping and install per condensing unit manufacturer's recommendations. Fabricate refrigerant piping of Type "L" hard drawn "ACR" tubing that has been cleaned and capped for refrigeration service. Fittings: wrought copper and installed with silver solder joints. Carefully clean the end of pipe and the inside of fittings before joining. Use no acid in cleaning or as a flux in soldering joints. Bleed nitrogen through piping while soldering.

B. Furnish, size, install, and insulate refrigerant pipe for the system as shown. Submit shop drawings of piping system showing traps, if required, pipe sizes, and accessories. Pipe sizes to be as recommended by unit manufacturer. Submit line sizing calculations for review by Engineer.

C. Provide replaceable core type liquid line filter dryer size for system capacity at 2 PSIG pressure drop per ARI 710, sight glass-moisture indicator.

## 2.02 CONDENSING UNITS

A. Heavy gauge galvanized steel cabinet. Baked-on outdoor enamel finish. Heavy duty steel base channels. Removable service access panels.

B. Compressor: Hermetically sealed with built-in protection from excessive current and temperatures. Crankcase heater. Compressor installed in the unit on resilient rubber mounts. Provide 5 year warranty.

C. Refrigerant System: Suction and liquid lines stubbed outside the cabinet for sweat connections. Noncorrosive suction and liquid line service valves with gauge ports. A thermometer well for checking refrigerant charge. High capacity drier. High pressure switch, manual reset, low pressure switch, automatic reset.

D. Condenser Fan: Direct drive fan. Vertical discharge. Fan motor, totally enclosed, inherently protected and equipped with a rain shield. Fan service access is accomplished by removal of fan guards. Corrosion resistant PVC (polyvinyl chloride) coated steel wire guard.

E. Condenser Coil: Coil constructed of ripple-edge aluminum fins machine fitted to seamless tubes. Coil factory tested under high pressure. Entire coil accessible for cleaning. Noncorrosive PVC coated steel wire coil guard.

F. Controls: High- and low-pressure cut-out switches, compressor overload devices, anti-short cycle controls which prevents compressor from restarting for approximately 5 minutes after shutoff. Provide a transformer for control circuits.

G. Low ambient control.

H. Refrigerant Piping: Type "L" copper tubing with suction piping insulated with 1/2-inch foamed plastic insulation.

I. Manufacturers: Mitsubishi, Carrier, Bryant, Lennox, Rheem, Trane, or approved.

## 2.03 MINI-SPLIT-SYSTEM AIR CONDITIONING UNITS

A. Indoor Units: Compact wall-mounted units. Supplementary electric heater, size as scheduled. Cabinet finish as selected by Architect. Isolate moving parts from cabinets to reduce noise.

B. Outdoor Units:
1. Compressor: Rotary or scroll design.
2. Fans: Direct driven and discharge horizontally.
3. Casing: Fully weatherproof for outdoor installations.
4. Microprocessor Controls: Factory wired with field installed remote pendant station.
5. Refrigerant: R-410a.
6. Isolate moving parts from cabinets to reduce noise.
7. Use dry-charged tubing for connection of unit's refrigerant system.

C. Manufacturers: Carrier, Friedrich, Mitsubishi, Sanyo.

## 2.04 COOLING COILS

A. Bohn, Carrier, Lennox, Trane, McQuay, or approved. Coils constructed with aluminum fin mechanically bonded to 1/2- or 5/8-inch copper tubes. Minimum tube wall thickness 0.018 inch; minimum fin thickness of 0.010 inch and maximum 14 fins per inch. Coils complete with expansion valve and distribution header. Coil capacity is to match associated remote condensing unit.

## 2.05 (AIR-AIR) HEAT PUMP CONDENSING UNITS

A. Coils: Seamless copper tubes with copper or aluminum plate fins mechanically bonded to the tubes.

B. Fans: Direct driven, propeller type, arranged for vertical discharge, with safety guards.

C. Motors: Permanently lubricated, on vibration isolators.

D. Compressor: Hermetic sealed design, with external spring isolators, automatically reversible oil pump, located in a section separated from condenser fans and coil. Provide low ambient controls. Provide 5 year warranty.

E. Controls: High- and low-pressure cut-out switches, compressor overload devices, anti-short cycle controls which prevents compressor from restarting for approximately 5 minutes after shutoff. Provide a transformer for control circuits.

F. Casing: Galvanized steel, designed for outdoor installation. Finished with baked enamel. Provide openings for power and refrigerant connections. Panel: Removable to provide access for servicing.

G. Connections for liquid line, suction line, and power supply.

H. Manufacturers: Carrier, Lennox, Bryant, Rheem, Trane, or approved.

# PART 3 - EXECUTION

## 3.01 AIR-COOLED CONDENSING UNITS INSTALLATION

A. Connect refrigerant piping to unit, run piping so as not to interfere with access to unit. Install furnished field mounted accessories. Verify manufacturer's requirements and provide accumulator when required due to length of refrigerant piping.

## 3.02 INSULATION

A. Insulate refrigerant piping, condensate drains, drip pans, and other associated appurtenances.

## 3.03 REFRIGERANT SYSTEM INSTALLATION

A. Piping: Install refrigerant piping per unit manufacturer's latest published recommendations straight and free from kinks and restrictions, properly supported by Trisolator or Cush-A-Strip S-715 to minimize vibration. Furnish and install straps or hangers at 5-foot spacing for 1/2-inch lines, 6-foot spacing for 1-inch lines. Pass a slow stream of dry nitrogen through the tubing at all times while soldering to eliminate the formation of copper oxide inside the tubing.

B. Slope lines to facilitate oil return to compressor. Provide suction line traps per manufacturer's recommendations. Install refrigerant piping as shown except make modifications as recommended by equipment unit manufacturer. Make such modifications at no cost to the Owner.

C. Test piping to recommended manufacturer test pressure.

D. After dehydration, introduce the manufacturer's recommended type and quantity of refrigerant into system through a filter/dryer.

**END OF SECTION**

# SECTION 23 75 00

# AIR HANDLING UNITS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Work Included: Materials, installation and testing of central station air handling unit.

### 1.2 QUALITY ASSURANCE

A. Regulatory Requirements:
1. ANSI/NFPA 90A, Installation of Air Conditioning and Ventilation Systems.
2. AMCA Compliance: Test and rate per AMCA 210 and 500.
3. ARI Compliance: Test and rate per ARI 430-99, Central Station Air Handling Units.
4. ARI Compliance: Test and rate coils per ARI 410-2001, Forced-Circulation Air-Cooling and Air-Heating Coils.
5. UL: Provide units and components which are labeled and listed by UL.

### 1.3 SUBMITTALS

A. Submit For: Air handlers.

B. Coil Selection: Submit manufacturer's computer-generated output data.

## PART 2 - PRODUCTS

### 2.1 FILTER GAUGES

A. Provide Dwyer 2000 Magnehelic gauges.

B. Magnehelic gauge to be accurate to plus or minus 2 percent of full range. Weatherproof glass.

C. Provide sensing probes and shutoff valves for each gauge.

D. Provide gauge for each filter bank.

### 2.2 CUSTOM AIR HANDLING UNITS

A. Unit Casing:
1. Unit shall be constructed of a complete frame with easily removable panels. Removal of any panel shall not affect the structural integrity of the unit. Single height coil sections shall have removable frame sections to facilitate vertical coil extraction.
2. All units shall be supplied with G-90 galvanized steel base rails. Bolt-on legs are NOT acceptable. Perimeter 10-gage lifting lugs for overhead lifting shall be provided on each section. Slinging units in place of lifting lugs shall not be acceptable.
3. Unit shall be thermally broken to minimize the conduction path from the inside of the casing to the outside.

4. Casing panels (top, sides, and bottom) shall be constructed of galvanized steel, and shall have one of the following exterior finishes as specified: Pre-painted with a baked enamel finish passing 500-hour salt spray test (ASTM B-117) for pre-painted steel and 125-hour marine level 1 prohesion test (ASTM G-85.A5) for pre-painted steel.
5. Casing panels (top, sides, and bottom) shall have no exterior exposed raw edges that could lead to rust formation. All casing corners shall be radiused or chamfered.
6. Casing panels (top, sides, and bottom) shall be one piece, double-wall construction with insulation sealed between the inner and outer panels. Panel assemblies shall not carry an R-value of less than 13.
7. Casing deflection shall not exceed a 1:200 ratio when subject to an internal pressure of ± 5-in. wg.
8. Side panels shall be easily removable for access to unit and shall seal against a full perimeter automotive style gasket to ensure a tight seal.
9. The panel retention system shall comply with UL 1995 which states all moving parts (for example, fan blades, blower wheels, pulleys, and belts) that, if accidentally contacted, could cause bodily injury, shall be guarded against accidental contact by an enclosure requiring tools for removal.
10. Accessibility shall be as follows:
    a. Hinged double-wall access doors on both sides. Provide removable double-wall access panels where there is not adequate room for an access door to fully open.
11. Provide:
    a. Thermal pane reinforced glass viewports shall be factory-installed on the access panel(s) or door(s) of the section.
    b. Marine lights shall be factory installed with convenience outlets.
12. Fan supports, structural members, panels, or flooring shall not be welded, unless aluminum, stainless steel, or other corrosion-resistant material is used. Painted welds on unit exterior steel or galvanized steel are not acceptable.
13. All coil sections shall be doublewall construction with insulation sealed between the inner and outer panels. Panel assemblies shall not carry an R-value of less than 13. Single height coil sections shall have removable frame sections to facilitate vertical coil extraction.

B. Access Doors: Access doors shall be one piece, double-wall construction with insulation sealed between the inner and outer panels. Panel assemblies shall not carry an R-value of less than 13.

C. Drain Pans: Drain pans shall be insulated double-wall or stainless steel construction. The pan shall be sloped in 4 directions toward the drain fitting. Drain pan shall have a recessed bottom drain design with 1-1/2-in. MPT connection exiting through the hand side or opposite side of the casing (see plans for locations). Drain connection shall be insulated from the drain pan to the point at which it exits the casing. One drain outlet shall be supplied for each cooling coil section. Drain pan shall allow no standing water and comply with ASHRAE Standard 62. Where 2 or more coils are stacked in a coil bank, intermediate drain pans shall be provided and the condensate shall be piped to the bottom drain pan. The bottom coil shall not serve as a drain path for the upper coil.

D. Casing:
1. Doublewall constructed unit to prevent fiberglass erosion into the airstream and to allow cleaning of the unit interior. 2-inch-thick interior wall of either 20 gauge solid galvanized steel. Foil faced insulation is not acceptable.
2. Ship fully assembled unit (within freight limitations) on a minimum 10 gauge galvanized steel base rail/housekeeping pad.
3. Seal all positive pressure section panels with closed-cell foam gasketing.

E. Insulation: Factory insulate unit with 2-inch, 1-1/2 lb. density, mat-faced insulation. Insulate connecting channels to prevent seating.

F. Outside Air/Return Air/Economizer Dampers: Provide outside air/return air dampers on filter mixing box to modulate the volume of outside and return air to perform economizer function. Airfoil design dampers and either parallel or opposed blade type with metal compressible jamb seals and extruded vinyl blade jamb seals on all blades. Rotate blades on stainless steel sleeve bearings. Maximum damper blade length to be 60 inches. Leakage rate not to exceed 5 CFM/sq.ft. at 2-inch w.g., 9 CFM/sq.ft. at 4-inch w.g.

G. Base Construction:
1. Construct base frame from structural steel galvanized channel around the perimeter of the unit, with intermediate channel and angle iron supports. Size members to freespan the unit.
2. All drain connections on air handling units to terminate at the side of the unit.

H. Filters: 4-inch-thick Merv-13 (see drawings) media contained in a rigid frame. Filters to have a rigid supporting maze across both the entering and leaving faces of the media. Size filters so as not to exceed scheduled face velocities. Provide manometer, mounted on exterior of unit, across filter section.

I. Fans:
1. Forward curve (FC) as required for proper operation, (reference Drawings).
2. Certify housed fan performance as complying with ARI 430-99. Dynamically balanced centrifugal fans at the factory as a complete fan assembly (fan wheel, motor, drive and belts). Fan shafts not to exceed 75 percent of their first critical speed at any cataloged RPM.
3. Equip fans with self-aligning anti-friction pillow block bearings with a minimum life of 200,000 hours. Equip bearings with grease lines allowing for lubrication from one side of the fan.
4. Internally isolate fan and motor assembly unit casing with spring isolators (2-inch deflection with seismic snubbers), furnished and installed by unit manufacturer. Isolate fan scroll from the unit by a flexible canvas duct.

J. Motors: Mount motors integral to an isolated fan assembly furnished by unit manufacturer. Mount motors inside the unit casing. Mount motors side base to permit adjustment of drive belt tension. Motors to be inverter rated and listed for use with variable frequency drives.

K. Coils:
1. All water coils shall be provided to meet the scheduled performance. All coil performance shall be certified in accordance with ARI Standard 410. All water coils shall be tested at 450 psig air pressure.
2. General Fabrication:
   a. Water coils shall have minimum 5/8-in. OD copper tubes mechanically expanded into fins to ensure high thermal performance with lower total flow and pumping requirements. Minimum tube wall thickness shall be 0.020 inches.
   b. Aluminum plate fin type with belled collars.
   c. Aluminum-finned coils shall be supplied with dieformed casing and tube sheets of mill galvanized steel or stainless steel as specified.

d. Fins to have collars drawn, belled and firmly bonded to the tubes by means of mechanical expansion of the tubes. Use no soldering or tinning in the bonding process. Mount coils in the unit casing to be accessible for service and can be removed from the unit either through the side or top. Certify capacities, pressure drops and selection procedure in accordance with ARI 410-2001.

3. Hydronic Heating and Cooling Coils:
   a. Headers shall be constructed of non-ferrous material (red brass or copper) with MPT connections. Headers shall have drain and vent connections accessible from the exterior of the unit. Provide non-ferrous nipples.
   b. Configuration: Coils shall be drainable, with non-trapping circuits. Coils will be tested and suitable for a design working pressure of 300 psig at 200 F.

L. Electrical: Single point electrical connection for each fan. Unit main control panel has factory mounted unit, fused disconnect switch, full voltage, non reducing, variable frequency drive, control power disconnect switch, 115V convenience outlet, and marine light, all accessible through integral front panel. Fans to be factory wired complete to load side of disconnect switch. Provide 24V control power transformer. Provide auxiliary relay to shut down unit on signal from ionization detector.

M. Manufacturers: Temtrol, Scott Springfield, or approved.

## PART 3 - EXECUTION

### 3.1 INSPECTION

A. Examine areas and conditions under units to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

### 3.2 UNIT INSTALLATION

A. General: Install units in accordance with manufacturer's installation instructions, plumb and level, and firmly anchor in locations indicated. Maintain manufacturer's recommended clearances.

B. Ductwork: Provide transitions to exactly match unit duct connection size.

C. Drain Piping: Provide trap at condensate drain; construct at least 1 inch deeper than fan pressure in inches of water.

D. Start-Up: Start up in accordance with manufacturer's instructions. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

E. Air Handling Units:
1. Install units on neoprene pad and secure as detailed (see structural drawings, Detail F on S2.1).
2. Rig and set units in place. Ensure that spreader bars are used and the units are protected from the lifting cables.
3. Entire air handling unit is to be leveled. Remove all internal hold down bolts and shipping fasteners, and install parts shipped loose.
4. Check and realign all access doors and dampers to ensure smooth operation through the entire range of travel.
5. Upon start-up each fan motor is to be checked for fan rotations, and amp draw for each phase. Amp readings are to be marked on the fan scroll.

6. All belt drives are to be readjusted for tension and alignment.
7. Provide a drain valve on each coil drain fitting, and a vent valve on each coil vent.
8. All pipe and conduit penetrations to the casing are to be thoroughly sealed and caulked to prevent air leakage.
9. Test installed unit for vibration and noise.

## 3.3 SPARE PARTS

A. Furnish to Owner, with receipt, for each unit:
   1. One set matched fan belts for each belt-driven fan.
   2. One complete set filters for each unit, not including new filters to be installed after testing and balancing.

## 3.4 INSULATION

A. Insulate piping, condensate drains, drip pans, and all other associated appurtenances per Section 23 07 00, HVAC Insulation.

**END OF SECTION**

# SECTION 25 55 00

# BUILDING MANAGEMENT AND CONTROL SYSTEM (BMS)

## PART 1 – GENERAL

### 1.01 SUMMARY

A. Description: Furnish all labor, materials, equipment, and service necessary to design, program, install and commission a complete and operating facility management and control system. The system shall be fully compatible throughout the Campus and shall utilize Direct Digital Controls, pneumatic/electronic interfaces and actuation devices, as described within the bid package and as additionally described herein. The BMS shall be capable of total integration of the facility infrastructure systems with user access to all system data either locally or over a secure Intranet within the building or by remote access utilizing a standard Web Browser (MS Explorer 6.0) over the Internet. This shall include the ability to perform HVAC control, electrical, gas and water metering, energy management, alarm monitoring, security and personnel access control, fire and life safety systems and all trending, reporting and maintenance management functions related to normal building operations.

B. The Drawings, Diagrams, Points Lists and Schematics are diagrammatic only and are intended to describe the overall concept and magnitude of the project. All labor, material, equipment and software not specifically referred to herein or on the Drawings, Diagrams, Points Lists and Schematics, that are required to meet the functional intent, shall be provided without additional cost to the Owner. The Contractor shall provide for all power required for control devices as well as structural support and attachments with any calculations and drawings required for permitting

C. All labor, material, equipment and software not specifically referred to herein that are required to meet the functional intent of this specification, shall be provided without additional cost to the owner.

### 1.02 SYSTEM DESCRIPTION, GENERAL

A. The entire BMS shall be comprised of a network of interoperable, stand-alone digital controllers communicating on an open protocol communication network to a host computer within the facility and communicating via the intranet to a host computer in a remote location.

B. The BMS shall be able to communicate to third party systems such as chillers, boilers, air handling systems, energy metering systems and other energy management systems, access control systems, fire-life safety systems and other building management related devices with open interoperable communication capabilities.

C. The BMS devices for this project shall be able to be part and fully interoperate with the existing Schneider Electric Enterprise Server Building Control Wide Area Network existing throughout the District, without having to use additional programming and configuration software.

Pursuant to Section 3400 of the Public Contract: Schneider Electric Enterprise Server Building Control Wide Area Network and Web Interface Systems is now in use on the particular public improvement described as San Mateo County Community College District. At each instance in these specifications that "Schneider Electric Enterprise Server Building Control Wide Area Network and Web Interface Systems" is designated by brand name, said manufacturer's system is required and is designated to coordinate with existing systems that are in place at Skyline College, College of San Mateo, Cañada College and the District Administration Building. The Contractor will furnish and install only "Schneider Electric Enterprise Server Building Control Wide Area Network and Web Interface Systems" systems and devices as required, and no substitutions shall be deemed to be "or equal" or allowed.

1.03 SUBMITTALS

A. A detailed work plan, phasing plan and proposed implementation schedule shall be submitted within 90 days of contract award.

B. Six copies of shop drawings of proposed system architecture and proposed products and equipment utilized in control system shall be submitted. The shop drawings shall consist of a complete list of equipment and materials, including manufacturers catalog data sheets and installation instructions. Shop drawings shall also contain complete wiring and schematic diagrams, software descriptions, calculations, and any other details required to demonstrate that the system will properly function as intended. At the time each modernization project is contracted and in coordination with the efforts of the respective contractors on the modernization work, shop drawings shall be prepared and forwarded to the General Contractor for the work related to that contract. The shop drawings shall respect the timing and sequencing of the General Contractor's schedule for submittals, and shall be complete in all respects for the scope of work under which the specific General Contractor would be responsible. Additionally, the shop drawings shall address how the control systems depicted would interface with and integrate with the overall system. Terminal identification for all control wiring shall be shown on the shop drawings. A complete written Sequence of Operation as well as a hard copy graphical depiction of the application control programs shall also be included with each submittal package.

C. Submittals shall also include a trunk cable schematic diagram depicting the Graphical User Interface (GUI) computer, control panel locations and a description of the communication type, media and protocol.

D. Upon completion of the work, provide a complete set of 'as-built' drawings and application software on compact disk. Drawings shall be provided as AutoCAD™ files.

1.04 RELATED WORK SPECIFIED UNDER SEPARATE SECTIONS

A. Division 22, Plumbing, and Division 23, Heating, Ventilating & Air Conditioning:

- Providing taps and installation of wells in piping for control system sensors and flow measurement devices.
- Installation of any control system dampers.

B. Division 25, Integrated Automation, and Division 26, Electrical:

- Providing motor starters and disconnect switches (unless otherwise noted).
- Provision, installation and wiring of smoke detectors (unless otherwise noted).
- Provide power to all DDC control panels

1.05 AGENCY AND CODE APPROVALS

A. All products of the BMS shall be provided with the following agency approvals. Verification that the approvals exist for all submitted products shall be provided with the submittal package. Systems or products not currently offering the following approvals are not acceptable.

- UL-916; Energy Management Systems
- ULC; UL - Canadian Standards Association
- FCC, Part 15, Subpart J, Class A Computing Devices

1.06 SOFTWARE LICENSE AGREEMENT

A. The Owner shall sign a copy of the manufacturer's standard software and firmware licensing agreement as a condition of this contract. Such license shall grant use of all programs and application software to Owner as defined by the manufacturer's license agreement, but shall protect manufacturer's rights to disclosure of trade secrets contained within such software.

1.07 DELIVERY, STORAGE AND HANDLING

A. Provide factory-shipping cartons for each piece of equipment and control device. Maintain cartons through shipping, storage, and handling as required to prevent equipment damage. Store equipment and materials inside and protected from weather.

1.08 JOB CONDITIONS

A. Cooperation with Other Trades: Coordinate the Work of this section with that of other sections to insure that the Work will be carried out in an orderly fashion. It shall be this Contractor's responsibility to check the Contract Documents for possible conflicts between his Work and that of other crafts in equipment location, pipe, duct and conduit runs, electrical outlets and fixtures, air diffusers, and structural and architectural features.

1.09 QUALITY ASSURANCE

A. The Manufacturer of the Temperature Control System shall provide documentation supporting compliance with ISO-9001 (Model for Quality Assurance in Design/Development, Production, Installation and Servicing). Product literature provided by the temperature control system manufacturer shall contain the ISO-9001 Certification Mark from the applicable registrar.

## 1.10 QUALIFICATIONS OF BIDDER

A. All bidders must be temperature control contractors in the business of installing direct digital temperature controls for five (5) years.

B. All bidders must have installed and completed at least five (5) direct digital temperature control jobs of similar design equipment as specified.

C. All bidders must be able to provide 24 hour service with 2 hour response time. This scope is provided under a separate contract.

D. All bidders must be an authorized distributor of the pre-qualified manufacturers specified and listed below.

E. All bidders must have capabilities of doing component level repairs on electronic systems.

F. Complete turnkey in-house staff for: Installation, Engineering, Programming, Test, Training, and Check-out.

G. The following bidder and product is pre-qualified:

1. ENTERPRISE SERVER Web Interface System - Installed by Schneider Electric

Schneider Electric
Chris Wilkins
1555 Bayshore Highway Suite 200
Burlingame, CA 94010
(650) 616-7403
chris.wilkins@buildings.schneider-electric.com

# PART 2 - MATERIALS

## 2.01 GENERAL

A. The BUILDING MANAGEMENT AND CONTROL SYSTEM (BMS) shall be comprised of a network of interoperable, stand-alone digital controllers, host computer system(s) with GUI software, portable operator's terminals, modems, printers and other devices as specified herein.

B. The installed system shall provide secure password access to all features, functions and data contained in the overall BMS.

C. Specification Nomenclature:

| | |
|---|---|
| BMS | BUILDING MANAGEMENT AND CONTROL SYSTEM |
| NAC | Network Area Controller |
| SDC | Standalone Digital Controller |
| IDC | Interoperable Digital Controller |
| IA | IA Series, Interoperable LONMARK Controller |
| LIDC | Lighting Interface Digital Controller |

| | |
|---|---|
| WBI | Web Browser Interface |
| POT | Portable Operator's Terminal |
| POI | Power Measurement Interface |
| DDC | Direct Digital Controls |
| LAN | Local Area Network |
| WAN | Wide Area Network |
| OOT | Object Oriented Technology |
| PICS | Product Interoperability Compliance Statement |
| GP | Graphical Programmer |
| HMI | Human Machine Interface |
| PAC | Personnel Access Controller |
| ENTERPRISE SERVER | Schneider Electric Graphical User Interface |

2.02 OPEN, INTEROPERABLE, INTEGRATED ARCHITECTURES

A. The intent of this specification is to provide a peer-to-peer networked, stand-alone, distributed control system with the capability to integrate LonWorks Technologies using Free Topology Transceivers (FTT-10), and specific conformance to the LONMARK Interoperability Association's v3.1 Physical and logical Layer guidelines in all unitary, terminal unit and other devices or both communication protocols in one interoperable system.

B. The supplied computer software system shall employ object-oriented technology (OOT) for representation of all data and control devices within the system. In addition, adherence to industry standards including LonMark to assure interoperability between all system components is required. For each LonWorks device that does not have LonMark certification, the device supplier must provide an XIF file for the device.

C. All components and controllers supplied under this contract shall be true "peer-to-peer" communicating devices. Components or controllers requiring "polling" by a host to pass data shall not be acceptable.

D. The supplied system must incorporate the ability to access all data using Java enabled browsers without requiring proprietary operator interface and configuration programs. An Open DataBase Connectivity (ODBC) or Structured Query Language (SQL) compliant server database is required for all system database parameter storage. This data shall reside on a supplier-installed server for all database access. Systems requiring proprietary database and user interface programs shall not be acceptable.

E. A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer's internal Intranet network. Systems employing a "flat" single tiered architecture shall not be acceptable.

1. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 5 seconds for network connected user interfaces.
2. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 60 seconds for remote or dial-up connected user interfaces.

## 2.03 NETWORKS

A. The Local Area Network (LAN) shall be residing on the existing SMCCCD Ethernet network supporting Java, XML, HTTP and COBRA IIOP for maximum flexibility for integration of building data with enterprise information systems and providing support for multiple Network Area Controllers (NACs), user workstations and, if specified, a local host computer system.

B. Access to the system from a remote location shall be via the utilizing an adequate PC with standard web browser and from a local computer system (by owner) via direct connection to the Ethernet LAN or thru VPN.

C. Local area network minimum physical and media access requirements:
1. Ethernet; IEEE standard 802.3
2. Cable; 10 base-T, UTP-8 wire, category 5
3. Minimum throughput; 10Mbps with ability to increase to 100 Mbps

## 2.04 NETWORK AREA CONTROLLER (NAC)

A. The Network Area Controller (NAC) shall provide the interface between the LAN or WAN and the field control devices, and provide global supervisory control functions over the control devices connected to the NAC. It shall be capable of executing application control programs to provide:
1. Calendar functions
2. Scheduling
3. Trending
4. Alarm monitoring and routing
5. Time synchronization
6. Integration of LonWorks controller data
7. Network management functions for all LonWorks devices

B. The NAC shall provide multiple user access to the system and support for ODBC or SQL. An embedded database resident on the NAC must be an ODBC-compliant database or must provide an ODBC data access or must provide an ODBC data access mechanism to read and write data stored within it.

C. The NAC must provide the following hardware features as a minimum:
1. One Ethernet port –10 / 100 Mbps
2. Two RS-232 ports
3. One LonWorks port – 78KB FTT-10A
4. Battery backup
5. Flash memory for long term data backup (If battery backup or flash memory is not supplied, the controller must contain a hard disk with at least 1-gigabyte storage capacity)
6. The NAC must be capable of operation over a temperature range of 0-55°C
7. The NAC must be capable of withstanding storage temperatures of between 0 and 70°C
8. The NAC must be capable of operation over a humidity range of 5-95% non-condensing

D. The NAC must provide all tools for Java enabled Web browser access via the Intranet/Internet. It shall support a minimum of 16 simultaneous users in its minimum configuration.

E. Event Alarm Notification and Actions

1. The NAC shall provide alarm recognition, storage; routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.

2. The NAC shall be able to route any alarm condition to any defined user location whether connected to a local network or remote via dial-up, telephone connection, or wide-area network.

3. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including but limited to:
    a) To alarm
    b) Return to normal
    c) To fault

4. Provide for the creation of an unlimited number of alarm classes for the purpose of routing types and or classes of alarms, i.e.: security, HVAC, Fire, etc.

5. Provide timed (schedule) routing of alarms by class, object or node.

6. Provide alarm generation from binary object "runtime" and /or event counts for equipment maintenance. The user shall be able to reset runtime or event count values with appropriate password control.

7. Control equipment and network failures shall be treated as alarms and annunciated.

8. The systems shall be capable to annunciate alarms in the following manners:
    a) Screen message text
    b) Email of the complete alarm message to multiple recipients. Provide the ability to route and email alarms based on day of the week, time of day and recipient.
    c) Pagers via paging services that initiate a page on receipt of email message.
    d) Graphic with flashing alarm object(s)
    e) Printed message, routed directly to a dedicated alarm printer
    f) Audio messages

9. The following shall be recorded by the NAC for each alarm (at a minimum):
    a) Time and date
    b) Location (building, floor, zone, etc.
    c) Equipment (air handler, etc.)
    d) Acknowledge time, date and user who issued acknowledgement
    e) Number of occurrences since last acknowledgement

10. Alarm actions may be initiated by user defined programmable objects created for that purpose.

11. Defined users shall be given proper access to acknowledge any alarm, or specific types or classes of alarms defined by the user.

12. A log of alarms shall be maintained by the NAC and/or a server (if configured in the system) and shall be available for review by the user.

13. Provide a "query" feature to allow review of specific alarms by user defined parameters.

14. A separate log for system alerts (controller failures, network failures, etc.) shall provided and available for review by the user.

15. An Error Log to record invalid property changes or commands shall be provided and available for review by the user.

F. Data Collection and Storage

1. The NAC shall be provided with the ability to collect data for any property of any object and store this data for future use.

2. The data collection shall be performed by a log object that shall have, at a minimum, the following configurable properties:

    a) Designating the log as interval or deviation.

    b) For interval logs, the object shall be configured for time of day, day of week and the sample collection interval.

    c) For deviation logs, the object shall be configured for the deviation of a variable to a fixed value. This value, when reached, will initiate logging of the object.

    d) For all logs, provide the ability to set the maximum number of data stores and to set whether the log will stop collecting when full, or rollover the data on a first-in, first-out basis.

    e) Each log shall have the ability to have its data cleared on a time-based event or by a user-defined event or action.

3. All log data shall be stored in a relational data base in the NAC and the data shall be accessed from a server (if the system is so configured) or a standard Web Browser.

4. All log data shall be available to the user in the following formats:
    a) HTML
    b) XML
    c) Plain text
    d) Comma or tab separated values

5. The NAC shall have the ability to archive it's log data via a server on the network. Provide the ability to configure the following archiving properties, at a minimum:
    a) Archive on time of day
    b) Archive on user-defined number of data stores in the log (buffer size)
    c) Archive when log has reached it's user-defined capacity of data stores
    d) Provide ability to clear logs once archived
6. The NAC shall provide and maintain an Audit Log that tracks all activities performed on the NAC. Provide the ability to specify a buffer size for the log and the ability to archive log based on time or when the log has reached it's user-defined buffer size. Provide the ability to archive the log locally (to the NAC), to another NAC on the network, or to a server. For each log entry, provide the following data:
    a) Time and date
    b) User ID
    c) Change or activity: i.e., Change setpoint, add or delete objects, commands, etc.
7. Data Base back up and storage:
    a) The NAC shall have the ability to automatically backup its database. The database shall be backed up monthly.
    b) Copies of the current database and, at the most recently saved database shall be stored in the NAC.
    c) The NAC database shall be stored, at a minimum, in XML format to allow for user viewing and editing, if desired. Other formats are acceptable as well, as long as XML format is supported.

## 2.05 STANDALONE DIGITAL CONTROLLERS (INVENSYS IA-SERIES)

General

A. The SDC controllers shall permit the simultaneous operation of all control, communication facilities management and operator interface software, as programmed by the Contractor or User. Modification of the on-board SDC controller database shall be performed on-line using the built-in interface. Systems that require the SDC to be removed from service while DDC control sequences are modified shall not be acceptable.

B. SDC controllers shall utilize true floating-point arithmetic capabilities. To accommodate totalization of large totalized values, SDCs with reporting capability shall support the calculation, accumulation and display of values within the range of +/-10 to the 10th power. The SDC shall employ a multi-tasking, multi-user operating system.

C. All programming defining the functions to be performed by the SDC, including but not limited to application programs and point database within each SDC shall be protected from loss due to power failure for a minimum of six months. Systems not providing non-volatile memory shall provide a system rechargeable battery backup system sufficient to provide protection for the specified 6 month period.

D. SDC controllers shall be equipped with a minimum of two operator service ports for the connection of serial devices such as the GP, HMI, modems, printers, etc. Connection of a service device, to a service port, shall not cause the SDC controller to lose communications with its peers or other networked device controllers. The SDC shall be able to route alarms, trends, and reports to any serial device connected to the network. This shall also include the auto dialing to remote locations. The SDC shall be capable of dialing out to a minimum of ten remote locations for the annunciation of alarms. Alarms shall include the time, date, and alarm condition, in addition to a user-defined detailed message detailing the condition.

E. The SDC shall provide Alarming, point trending and Energy report generation capabilities. Alarming points shall be uniquely definable, with multiple alarms assignable to a single point. Such alarms shall be provided with a unique 80-character message. Systems utilizing an alarm messages library, shall describe the size of the library and verify how all alarming within the SDC will be guaranteed unique 80 character messages.

F. The quantities of trended point values shall be limited only by total controller memory space. If necessary, a SDC may be dedicated fully to a trending task, allowing all controller memory to be available for the trend storage. Each unique trend report shall contain a minimum of 4 different points and a minimum of 128 samples per point. Trending frequency for each report shall be operator definable from a sample once a second to a sample once every 24 hours. Trend reports shall be internally formatted by the SDC and shall be reportable directly to a serial printer, a VT-100 display terminal, a CCS, CHS or any other device capable of receiving a formatted ASCII data file.

G. The energy reports shall not be limited in quantities only by available memory within the GDC. Each Energy report shall be fully formatted and reportable to a serial printer, a VT-100 display terminal, a CCS, a CHS or any other device capable of receiving a formatted ASCII data file. As a minimum, each Energy report shall provide a daily report and a monthly report with summary information such as outside air temperature, outside air humidity, total energy consumed and degree-day calculations.

H. The SDC controller shall provide a built-in operator interface, which consists of an alphanumeric LCD display of 4 lines x 20 characters, and a multi-function keyboard. Devices without such built-in displays shall provide a permanently connected HMI as described elsewhere in this specification, one per SDC.

I. The SDC shall provide for logical grouping of network variables and allow for viewing and editing of system parameters. Logical grouping menus shall allow for detailed descriptions of system variables of a minimum of 20 characters.

J. The SDC shall communicate via the BMS Network Interfaces to the enterprise LAN, whether dedicated or common. The SDC shall provide communications connectivity to the LonWorks bus and shall support any LONMARK/LonWorks compliant devices.

K. The SDC shall provide connectivity to the currently marketed BMS solutions offered by the manufacturer. The SDC shall be interoperable these BMS offerings for scheduling, global data sharing, Energy Demand Limiting, alarming, optimized start/stop, and systems integrations for all other data within the entire BMS. In addition, the SDC shall provide connectivity to existing DDC controllers currently marketed by the manufacturer.

L. The SDC shall be compliant with the current and previously marketed HMIs of the manufacturer, and shall be capable of full bi-directional communications through the LAN, with previously manufactured SDC controllers sold for the last ten years by the manufacturer.

## 2.6 INTEROPERABLE LONMARK CONTROLLERS (INVENSYS IA-SERIES)

General

A. Controls shall be microprocessor based Interoperable Invensys IA Series Controllers (IA), bearing the applicable LONMARK interoperability logo on each product delivered. IAs shall be provided for Unit Ventilators, Fan Coils, Heat Pumps, VAV Terminal Boxes and other applications as shown on the drawings. IAs shall be based on the Echelon Neuron 3150 microprocessor working from software program memory which is physically located in the IA. The application control program shall be resident within the same enclosure as the input/output circuitry, which translates the sensor signals.

B. To simplify controls and mechanical service troubleshooting, the IA shall be mounted directly in the control compartment of the unitary system. The IA shall be provided with a sheet metal or polymeric enclosure that is constructed of material allowing for the direct mounting within the primary air stream, as defined by UL-465. The direct mounting shall allow all controls maintenance and troubleshooting to be made while at the unitary equipment.

C. The IAs shall communicate with the SDC at a baud rate of not less than 78.8K baud. The IA shall provide LED indication of communication and controller performance to the technician, without cover removal.

D. The IAs shall be fully supported and communicate with any and all GUI(s) on the bus.

E. S-Bus Sensor
The S-Bus Sensor shall connect directly to the IA controller and shall not utilize any of the I/O points of the controller. The S-Bus Sensor shall provide a two-wire connection to the controller that is polarity and wire type insensitive. The S-Bus Sensor shall provide a communications jack for connection to the LON communication trunk to which the IA controller is connected. The S-Bus Sensor, the connected controller, and all other devices on the LON bus shall be accessible by the Graphical Programming tool.

The S-Bus Sensor shall be available in the following variations;
Tamper-resistant (no display)
Tamper-resistant with tenant override
Basic user functions (LCD display and setpoint adjustment and tenant override)
Full user functions (LCD display and network-variable access and tenant override)
ASHRAE 95 compliance (LCD display and sub-base functionality)

The S-Bus Sensor shall be provided in a modular configuration that allows for the rough in of all wiring without the presence of the electronics or esthetic covering. The IA Sensor shall allow for the customization of the color on the esthetic covering as a standard offering. User interface with the IA Sensor shall be provided as a configurable function by the BMS, and shall offer password protection for access to network variable editing. Multiple network variables shall be accessible and editable by the IA Sensor. Icons shall be utilized to represent sensor and controller function status, affording independence from a single language for use interface.

F. IA Controller Functionality

The IA CONTROLLER shall provide a –40 to 140 degree Fahrenheit ambient operating temperature range. The IA CONTROLLER shall be provided in a modular configuration that allows for the rough in of all wiring without the presence of any of the IA Controller electronics. IA Controller devices that require the electronics to be present at the time of wiring, will require an additional controller to be provided for every 10 devices on the drawings, to allow for the preconfiguration and storing for service purposes.

G. All input/output signals shall be directly hardwired to the IA Controller. For all non-VAV terminal applications, a minimum of two input points of the IA Controller shall employ a universal configuration that allows for flexibility in application ranging from dry contact, resistive, to voltage/current sourced inputs. If universal points are not available, a minimum of two input points (each) of the dry contact, resistive and analog voltage/current types must be provided on every controller. The outputs of the IA Controller shall be of the relay and universal analog form. All digital outputs shall be relay type. IA Controller devices utilizing non-relay outputs shall provide an interface relay for all points. All analog outputs shall be programmable for their start points and span to accommodate the control devices. Configuration of all I/O points shall be accomplished without physical hardware jumpers, switches or settings. Troubleshooting of input/output signals shall be easily executed with the Graphical Programming tool (GP) or a volt-ohm meter (VOM). All I/O points shall be utilized by the local IA Controller or shall be available as I/O points for other controllers throughout the network.

H. All IA Contollers shall be fully application programmable and shall at all times maintain their LONMARK certification. Controllers offering application selection only (non-programmable), require a 10% spare point capacity to be provided for all applications. All control sequences within or programmed into the IA Controller shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained.

I. The IA Controller shall be provided with the ability to interface with the Graphical Programming tool. The interface port shall be provided at the wall sensor or within the unitary equipment, as specified on the plans. The interface port shall allow the GP to have full functionality as described in GP section of this specification. Through the connected controller all IA Contoller devices on the LON bus shall be accessible by the Graphical Programming tool.

J. Mechanical equipment manufacturers desiring to provide IA Controller type controls as factory mounted equipment, shall provide a separate bid for their products less all controls, actuators, valve assemblies and sensors, which are specified to be provided by the BMS contractor.

K. VAV Controller Functionality (INVENSYS IA-SERIES)

1. Controls shall be microprocessor based Pressure Independent Variable Air Volume Digital Controllers, as shown in the drawings. The VAV IA controller shall be a single integrated package consisting of a microprocessor, power supply, damper actuator, differential pressure transducer, field terminations, and application software. An alternate model shall be offered that allows for direct connectivity to an external actuator for those applications that employ a non-butterfly style damper configuration. All input/output signals shall be directly hardwired to the VAV IA controller. The internal actuator shall employ a manual override that allows for powered or non-powered adjustment of the damper position. In all cases, the controller shall automatically resume proper operation following the return of power to, or control by the IA. Programming, configuring and/or troubleshooting of input/output signals shall be easily executed through the IA sensor or GP tool connected at the wall sensor location.

2. The VAV IA control algorithms shall be designed to limit the frequency of damper repositioning, to assure a minimum 10-year life from all components. The VAV IA contoller shall provide internal differential pressure transducer for pressure independent applications with an accuracy of ± 5 %. Flows through transducers requiring filter maintenance are not acceptable. The VAV IA shall provide zone control accuracy equal to or better than +/- 1 degree Fahrenheit. Systems providing control accuracy's greater than +/- 1 degrees Fahrenheit are not acceptable. With the submittal package, contractor shall provide performance data that verifies control accuracy of the VAV IA controller.

3. All input/output signals shall be directly hardwired to the VAV IA controller. A minimum of one input point of the VAV IA controller shall employ a universal configuration that allows for flexibility in application ranging from dry contact, resistive, to voltage/current sourced inputs. If a universal point is not available, a minimum of one input point (each) of the dry contact, resistive and analog voltage/current types must be provided on every controller. The outputs of the IA controller shall be of the relay and universal analog form. All digital outputs shall be relay type. IA devices utilizing non-relay outputs shall provide an interface relay for all points. All analog outputs shall be programmable for their start points and span to accommodate the control devices. Configuration of all I/O points shall be accomplished without physical hardware jumpers, switches or settings. Troubleshooting of input/output signals shall be easily executed with the Graphical Programming tool or a volt-ohm meter (VOM). All I/O points shall be utilized by the local IA controller or shall be available as I/O points for other controllers throughout the network.

4. The BMS contractor shall provide VAV IA controller to the VAV box manufacturer, for factory mounting. The VAV terminal unit supplier shall include in its price all costs for mounting of VAV IA controller, connection of actuator to damper shaft, wiring of device power, wiring of VAV IA controller to fan (fan powered terminal) and wiring to electric reheat coils or reheat valve actuator as specified on drawing.

5. The VAV terminal manufacturer shall provide a multi-point, averaging, differential pressure sensor mounted on the inlet to each VAV box. The VAV terminal unit manufacturer shall supply a line to low voltage transformer, of sufficient capacity, to power the VAV IA controller plus all reheat valves and/or contactors and fan circuits associated with the VAV terminal and actuator assemblies. The BMS contractor shall provide all reheat control valves to the mechanical contractor for mounting and piping. The BMS contractor shall provide and install all wiring between the valve and VAV IA controller and between the room sensor and the VAV IA controller.

L. IA VAV - Air Balancing

Through the portable tool, the VAV IA controller shall support a fully prompted Air Balance sequence. The GP tool shall, when connected through the wall sensor, access the connected VAV IA unit. The air balance sequence shall step the balancing contractor through the checkout and calibration of the VAV IA controller. Upon completion of the balancing sequence, the flow values presented by the VAV IA shall match those observed by the balancing contractor's measurement equipment. Additionally, upon completion of the air balance, the SDC shall automatically archive the balance settings for future use if the controller were to require replacement. The BMS contractor will provide the software tool and cable to the balancer at no cost with a one time one hour instruction. The balancing contractor is required to return the tool in working order as soon as he completes his work.

## 2.07 SYSTEM PROGRAMMING

A. The system supplied by the installer must be programmed using “Java” objects. A library of control, application, and graphical objects shall be provided to enable the creation of all applications and user interface screens. Applications are to be created by selecting the desired control objects from the library, dragging or pasting them on the screen, and “wiring” them together using a built in graphical connection tool. Completed applications may be stored in the library for future use. Graphical User screens are created in the same fashion. Data for the user screens is obtained by graphically linking the user screen objects to the application objects to provide “real-time” data updates. Any real-time data value or object property may be connected to display its current value on a user screen. Systems requiring separate software tools or processes to create applications and user interface screens shall not be acceptable.

B. Programming Methods

1. Provide the capability to copy objects from the supplied libraries, or from a user-defined library to the user’s application. Objects shall be linked by a graphical soft-wiring scheme by dragging a link from one object to another. Object links will support one-to-one, many-to-one, or one-to-many relationships. Linked

objects shall maintain their connections to other objects regardless of where they positioned on the page and shall show link identification for links to objects on other pages for easy identification. Links will vary in color depending on the type of link; i.e., internal, external, hardware, etc.

2. Configuration of each object will be done through the object's property sheet using fill-in the blank fields, list boxes, and selection buttons. Use of custom programming, scripting language, or a manufacturer-specific procedural language for configuration will not be accepted.

3. The software shall provide the ability to view the logic in a monitor mode. When on-line, the monitor mode will provide the ability to view the logic in real time for easy diagnosis of the logic execution. When off-line, the monitor mode will allow the user to set values to inputs and monitor the logic for diagnosing execution before it is applied to the system.

4. All programming shall be done in real-time. Uploading, editing, and downloading of database objects shall not be allowed.

5. The system shall support object duplication within a customer's database. An application, once configured, can be copied and pasted for easy re-use and duplication. All links, other than to the hardware, shall be maintained during duplication.

2.08 GRAPHICAL USER INTERFACE SOFTWARE (Add to existing ENTERPRISE SERVER System)

A. Operating System: The GUI shall run on Microsoft Windows 2000 or later.

B. The GUI shall employ browser-like functionality for ease of navigation. It shall include a tree view (similar to Windows Explorer) for quick viewing of, and access to, the hierarchical structure of the database. In addition, menu-pull downs, and toolbars shall employ buttons, commands and navigation to permit the operator to perform tasks with a minimum knowledge of the HVAC Control System and basic computing skills. These shall include, but are not limited to, forward/backward buttons, home button, and a context sensitive locator line (similar to a URL line), that displays the location and the selected object identification.

C. Real-Time Displays. The GUI, shall at a minimum, support the following graphical features and functions:

1. Graphic screens shall be developed using any drawing package capable of generating a GIF, BMP, or JPG file format. Use of proprietary graphic file formats shall not be acceptable. In addition to, or in lieu of a graphic background, the GUI shall support the use of scanned pictures.

2. Graphic screens shall have the capability to contain objects for text, real-time values, animation, color spectrum objects, logs, graphs, HTML or XML document links, schedule objects, hyperlinks to other URL's, and links to other graphic screens.

3. Graphics shall support layering and each graphic object shall be configurable for assignment to a layer. A minimum of six layers shall be supported.

4. Modifying common application objects, such as schedules, calendars, and set points shall be accomplished in a graphical manner.
5. Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.
6. Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.

7. Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop-up menu. No entry of text shall be required.

8. Adjustments to analog objects, such as set points, shall be done by right-clicking the selected object and using a graphical slider to adjust the value. No entry of text shall be required.

D. System Configuration. At a minimum, the GUI shall permit the operator to perform the following tasks, with proper password access:

1. Create, delete or modify control strategies.
2. Add/delete objects to the system.
3. Tune control loops through the adjustment of control loop parameters.
4. Enable or disable control strategies.
5. Generate hard copy records or control strategies on a printer.
6. Select points to be alarmable and define the alarm state.
7. Select points to be trended over a period of time and initiate the recording of values automatically.

E. On-Line Help. Provide a context sensitive, on-line help system to assist the operator in operation and editing of the system. On-line help shall be available for all applications and shall provide the relevant data for that particular screen. Additional help information shall be available through the use of hypertext. All system documentation and help files shall be in HTML format.

F. Security. Each operator shall be required to log on to that system with a user name and password in order to view, edit, add, or delete data. System security shall be selectable for each operator. The system administrator shall have the ability to set passwords and security levels for all other operators. Each operator password shall be able to restrict the operators' access for viewing and/or changing each system application, full screen editor, and object. Each operator shall automatically be logged off of the system if no keyboard or mouse activity is detected. This auto log-off time shall be set per operator password. All system security data shall be stored in an encrypted format.

G. System Diagnostics. The system shall automatically monitor the operation of all workstations, printers, modems, network connections, building management panels, and controllers. The failure of any device shall be annunciated to the operator.

H. Alarm Console

1. The system will be provided with a dedicated alarm window or console. This window will notify the operator of an alarm condition, and allow the operator to view details of the alarm and acknowledge the alarm. The use of the Alarm Console can be enabled or disabled by the system administrator.

2. When the Alarm Console is enabled, a separate alarm notification window will supercede all other windows on the desktop and shall not be capable of being minimized or closed by the operator. This window will notify the operator of new alarms and un-acknowledged alarms. Alarm notification windows or banners that can be minimized or closed by the operator shall not be acceptable.

2.09 WEB BROWSER CLIENTS

A. The system shall be capable of supporting an unlimited number of clients using a standard Web browser such as Internet Explorer™ or Netscape Navigator™. Systems requiring additional software (to enable a standard Web browser) to be resident on the client machine, or manufacture-specific browsers shall not be acceptable.

B. The Web browser software shall run on any operating system and system configuration that is supported by the Web browser. Systems that require specific machine requirements in terms of processor speed, memory, etc., in order to allow the Web browser to function with the BMS, shall not be acceptable.

C. The Web browser shall provide the same view of the system, in terms of graphics, schedules, calendars, logs, etc., and provide the same interface methodology as is provided by the Graphical User Interface. Systems that require different views or that require different means of interacting with objects such as schedules, or logs, shall not be permitted.

D. The Web browser client shall support at a minimum, the following functions:

1. User log-on identification and password shall be required. If an unauthorized user attempts access, a blank web page shall be displayed. Security using Java authentication and encryption techniques to prevent unauthorized access shall be implemented.

2. Graphical screens developed for the GUI shall be the same screens used for the Web browser client. Any animated graphical objects supported by the GUI shall be supported by the Web browser interface.

3. HTML programming shall not be required to display system graphics or data on a Web page. HTML editing of the Web page shall be allowed if the user desires a specific look or format.

4. Storage of the graphical screens shall be in the Network Area Controller (NAC), without requiring any graphics to be stored on the client machine. Systems that require graphics storage on each client are not acceptable.

5. Real-time values displayed on a Web page shall update automatically without requiring a manual "refresh" of the Web page.

6. User's shall have administrator-defined access privileges. Depending on the access privileges assigned, the user shall be able to perform the following:
    a) Modify common application objects, such as schedules, calendars, and set points in a graphical manner.
    b) Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.
    c) Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.
    d) Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop-up menu. No entry of text shall be required.
    e) View logs and charts
    f) View and acknowledge alarms

7. The system shall provide the capability to specify a user's (as determined by the log-on user identification) home page. Provide the ability to limit a specific user to just their defined home page. From the home page, links to other views, or pages in the system shall be possible, if allowed by the system administrator.

8. Graphic screens on the Web Browser client shall support hypertext links to other locations on the Internet or on Intranet sites, by specifying the Uniform Resource Locator (URL) for the desired link.

## 2.10 DDE DEVICE INTEGRATION

A. The NAC shall support the integration of device data via Dynamic Data Exchange (DDE), over the Ethernet Network. The NAC shall act as a DDE client to another software application that functions as a DDE server.

B. Provide the required objects in the library, included with the Graphical User Interface programming software, to support the integration of these devices into the BMS. Objects provided shall include at a minimum:
    1. DDE Generic AI Object
    2. DDE Generic AO Object
    3. DDE Generic BO Object
    4. DDE Generic BI Object

## 2.11 LonWorks NETWORK MANAGEMENT

A. The Graphical User Interface software (GUI) shall provide a complete set of integrated LonWorks network management tools for working with LonWorks networks. These tools shall manage a database for all LonWorks devices by type and revision, and shall provide a software mechanism for identifying each device on the network. These tools shall also be capable of defining network data connections between LonWorks devices, known as "binding". Systems requiring the use of third party LonWorks network management tools shall not be accepted.

B. Network management shall include the following services: device identification, device installation, device configuration, device diagnostics, device maintenance and network variable binding.

C. The Network configuration tool shall also provide diagnostics to identify devices on the network, to reset devices, and to view health and status counters within devices.

D. These tools shall provide the ability to "learn" an existing LonWorks network, regardless of what network management tool(s) were used to install the existing network, so that existing LonWorks devices and newly added devices are part of a single network management database.

E. The network management database shall be resident in the Network Area Controller (NAC), ensuring that anyone with proper authorization has access to the network management database at all times. Systems employing network management databases that are not resident, at all times, within the control system shall not be accepted.

2.12 GRAPHICAL USER INTERFACE COMPUTER (provided by owner if required)

A. The desktop computer shall be an Intel Pentium based computer (minimum processing speed of 400 Mhz with 256 MB RAM and a 10-gigabyte minimum hard drive). It shall include a 32X CD-ROM drive, 3.5" floppy drive, a 100 MB Zip drive, 2-parallel ports, 2-asynchronous serial ports and 2-USB ports. A minimum 17", 28-dot pitch SVGA color monitor with a minimum 80 Hz refresh rate shall also be included.

B. A system printer shall be provided. Printer shall be laser type with a minimum 600 x 600-dpi resolution and rated for 8-ppm print speed minimum.

2.13 OTHER CONTROL SYSTEM HARDWARE

A. Control Damper Actuators (where furnished by the Temperature Control sub-contractor): Two-position or proportional electric actuators shall be direct-mount type sized to provide a minimum of 5 in-lb torque per square foot of damper area. Damper actuators shall be spring return type. Provide one actuator per damper minimum. Pneumatic actuators shall be sized to provide a minimum of 5 in-lb torque per square foot of damper area and shall include positive positioning pneumatic relays when sequenced with other actuators or when control action is to be proportional.

B. Control Valves: Control valves shall be 2-way or 3-way pattern as shown constructed for tight shutoff and shall operate satisfactorily against system pressures and differentials. Two-position valves shall be 'line' size. Proportional control valves shall be sized for a maximum pressure drop of 5.0 psi at rated flow (except as may be noted on the drawings). Valves with sizes up to and including 2 inches shall be "screwed" configuration and 2-1/2 inch and larger valves shall be "flanged" configuration. Electrically controlled valves shall include spring return type actuators sized for tight shut-off against system pressures and furnished with integral switches for indication of valve position (open-closed). Pneumatically actuators for valves, when utilized, shall be sized for tight shut-off against system pressures. Three-way butterfly valves, when utilized, shall include a separate actuator for each butterfly segment.

C. Wall Mount Room Thermostats: Each room thermostat shall provide temperature indication to the digital controller, provide the capability for a software-limited set point adjustment and operation override capability. An integral LCD shall annunciate current room temperature and set point as well as override status indication. In addition, the thermostat shall include a port for connection of the portable operator's terminal described elsewhere in this specification.

D. Duct Mount, Pipe Mount and Outside Air Temperature Sensors: 10,000-ohm thermistor temperature sensors with an accuracy of ± 0.2ºC. Outside air sensors shall include an integral sun shield.

E. Current Sensitive Switches: Solid state, split core current switch that operates when the current level (sensed by the internal current transformer) exceeds the adjustable trip point. Current switch to include an integral LED for indication of trip condition and a current level below trip set point.

F. Power Monitoring Interface: The Power Measurement Interface (PMI) device shall include the appropriate current and potential (voltage) transformers. The PMI shall be certified under UL-3111. The PMI shall perform continuous true RMS measurement based on 32 samples-per-cycle sampling on all voltage and current signals. The PMI shall provide outputs to the BMS based on the measurement and calculation of the following parameters: (a) current for each phase and average of all three phases, (b) kW for each phase and total of all three phases, (c) power factor for each phase and all three phases, (d) percent voltage unbalance and (e) percent current unbalance. These output values shall be hard-wired inputs to the BMS or shall be communicated to the BMS over the open-protocol LAN.

G. Water Flow Meters (when required): Water flow meters shall be axial turbine style flow meters which translate liquid motion into electronic output signals proportional to the flow sensed. Flow sensing turbine rotors shall be non-metallic and not impaired by magnetic drag. Flow meters shall be 'insertion' type complete with 'hot-tap' isolation valves to enable sensor removal without water supply system shutdown. Accuracy shall be ±2% of actual reading from 0.4 to 20 feet per second flow velocities.

H. Water Differential Pressure Switch: Switch shall measure the pressure difference between two sources and activate a SPDT switch upon an adjustable change in pressure differential. Pressure differential set point shall be adjustable between 8-70 psi. Switches shall be selected to withstand expected system pressures. Switch electrical rating shall be 20 amp at 120 VAC.

I. Ambient Light Sensor: Ambient light sensor designed to provide an analog output signal proportional to the ambient light present. Sensor shall contain a precision photo-diode type cell for light measurement. Sensor shall be designed for outdoor application and be directed towards the north sky, away from lighted signs, outdoor lights or similar light producing equipment. Maximum range shall be adjustable from 5 to 750 foot-candles at the sensor face. Accuracy shall be ±1% at 70 degrees F.

J. Temperature Control Panels: Furnish temperature control panels of code gauge steel with locking doors for mounting all devices as shown. Control panels shall meet all requirements of Title 24, California Administrative Code. All electrical devices within a control panel shall be factory wired. All external wiring shall be connected to terminal strips mounted within the panel. Provide engraved phenolic nameplates identifying all devices mounted on the face of control panels. A complete set of 'as-built' control drawings (relating to the controls within that panel) shall be furnished within each control panel.

## PART 3 - EXECUTION

### 3.01 INSTALLATION

A. All work described in this section shall be installed, wired, circuit tested and calibrated by factory certified technicians qualified for this work and in the regular employment of the temperature control system manufacturer or its exclusive factory authorized installing contracting field office (representative). The installing office shall have a minimum of five years of installation experience with the manufacturer and shall provide documentation in submittal package verifying longevity of the installing company's relationship with the manufacturer. Supervision, calibration and checkout of the system shall be by the employees of the local exclusive factory authorized temperature control contracting field office (branch or representative).

B. Install system and materials in accordance with manufacturer's instructions.

C. Line voltage electrical connections to control equipment shown specified or shown on the control diagrams shall be furnished and installed by Div. 16

D. Equipment furnished by the HVAC Contractor that is normally wired before installation shall be furnished completely wired. Control wiring normally performed in the field will be furnished and installed by the Temperature Control sub-contractor.

E. All control devices mounted on the face of control panels shall be clearly identified as to function and system served with permanently engraved phenolic labels.

### 3.02 CONTROL SYSTEM WIRING

A. All electrical control wiring and low voltage power wiring to the control panels shall be the responsibility of the BMS contractor. All 120 V power for control panels by Div.16

B. All wiring shall be in accordance with Division 16, the National Electrical Code and any applicable local codes. All BMS wiring shall be installed in the conduit types specified in the Project Electrical Specifications (Division 16) unless otherwise allowed by the National Electrical Code or applicable local codes. Where BMS plenum rated cable wiring is allowed it shall be run parallel to or at right angles to the structure, properly supported and installed in a neat and workmanlike manner.

C. All exposed wiring shall be routed within surface metal raceway painted to match adjacent surfaces and routed in a neat, unobtrusive manner, parallel to surfaces. The routing may often take a non-direct route to minimize its appearance and as such Contractor shall assume extra material and labor to allow for approach.

3.03 WARRANTY

A. Equipment, materials and workmanship incorporated into the work shall be warranted for a period of one year from the time of system acceptance.

B. Within this period, upon notice by the Owner, any defects in the BMS due to faulty materials, methods of installation or workmanship shall be promptly (within 48 hours after receipt of notice) repaired or replaced by the Temperature Control sub-contractor at no expense to the Owner

3.04 WARRANTY ACCESS

A. The Owner shall grant to the Temperature Control sub-contractor, reasonable access to the BMS during the warranty period. The owner shall provide VPN access at no cost to the contractor, for remote communication to the BMS during this period.

3.05 ACCEPTANCE TESTING

A. Upon completion of the installation, the Temperature Control sub-contractor shall load all system software and start-up the system. The Temperature Control sub-contractor shall perform all necessary calibration, testing and de-bugging and perform all required operational checks to insure that the system is functioning in full accordance with these specifications.

B. Graphical User Interface software documentation shall be provided in HTML document format with context-sensitive hyperlinks is an integral part of the graphical user interface and does not require separate hard-copy manuals.

C. The Temperature Control sub-contractor shall perform tests to verify proper performance of components, routines, and points. Repeat tests until proper performance results. This testing shall include a point-by-point log to validate 100% of the input and output points of the DDC system operation.

C. Upon completion of the performance tests described above, repeat these tests, point by point as described in the validation log above in presence of Owner's Representative, as required. Properly schedule these tests so testing is complete at a time directed by the Owner's Representative. Do not delay tests so as to prevent delay of occupancy permits or building occupancy.

E. System Acceptance: Satisfactory completion is when the Temperature Control sub-contractor has performed successfully all the required testing to show performance compliance with the requirements of the Contract Documents to the satisfaction of the Owner’s Representative. System acceptance shall be contingent upon completion and review of all corrected deficiencies.

## 3.06 OPERATOR INSTRUCTION, TRAINING

A. During system check-out and testing and at such time acceptable performance of the BMS hardware and software has been established the Temperature Control sub-contractor shall provide on-site operator instruction to the owner's operating personnel. Operator instruction shall be done during normal working hours and shall be performed by a competent representative familiar with the system hardware, software and accessories.

B. The Temperature Control sub-contractor shall provide 16 hours of instruction to the owner's designated personnel on the operation of the BMS system and describe its intended use with respect to the programmed functions specified. Operator orientation of the BMS system shall include, but not be limited to; the overall operation program, equipment functions (both individually and as part of the total integrated system), commands, systems generation, advisories, and appropriate operator intervention required in responding to the System's operation.

C. The training shall be in two sessions as follows:

1. Initial Training: One day session (8 hours) after system is started up and at least one week before first acceptance test. Manual shall have been submitted at least two weeks prior to training so that the owners' personnel can start to familiarize themselves with the system before classroom instruction begins.

2. First Follow-Up Training: One day session (8 hours) approximately two weeks after initial training, and before Formal Acceptance. These sessions will deal with more advanced topics and answer questions.

END OF SECTION

# SECTION 26 00 00

# BASIC ELECTRICAL REQUIREMENTS

## PART 1 - GENERAL

### 1.01 SUMMARY

A. Section Includes:

1. Electrical systems required for this work includes labor, materials, equipment, and services necessary to complete installation of electrical work shown on Drawings, specified herein or required for a complete operable facility and not specifically described in other Sections of these Specifications. Among the items required are:
   a. Distribution equipment.
   b. Feeders to distribution panels, HVAC equipment, Owner provided equipment and other equipment.
   c. Branch circuit wiring from distribution panels for lighting, receptacles, motors, signal systems, and other detailed wiring.
   d. Luminaires, control switches, receptacles, relays, supports, and other accessory items.
   e. Wiring and power connections for motors installed for heating, cooling, and ventilation.
   f. Fire alarm system.
   g. Low voltage systems.

### 1.02 DEFINITIONS

A. Following is a list of abbreviations generally used in Division 26:

| | | |
|---|---|---|
| 1. | ADA | Americans With Disabilities Act |
| 2. | AHJ | Authority Having Jurisdiction |
| 3. | ANSI | American National Standards Institute |
| 4. | APWA | American Public Works Association |
| 5. | ASTM | American Society for Testing and Materials |
| 6. | CBC | California Building Code |
| 7. | CEC | California Electrical Code |
| 8. | CFC | California Fire Code |
| 9. | FCC | Federal Communications Commission |
| 10. | HVAC | Heating, Ventilating and Air Conditioning |
| 11. | IEC | International Electrotechnical Commission |
| 12. | IEEE | Institute of Electrical and Electronics Engineers. |
| 13. | IETA | International Electrical Testing Association |
| 14. | FM | FM Global |
| 15. | NEMA | National Electrical Manufacturers Association |
| 16. | NFPA | National Fire Protection Association |
| 17. | OSHA | Occupational Safety and Health Administration |
| 18. | UL | Underwriters Laboratories Inc. |

B. Provide: To furnish and install, complete and ready for the intended use.

C. Furnish: Supply and deliver to the project site, ready for unpacking, assembly and installation.

D. Install: Includes unloading, unpacking, assembling, erecting, installation, applying, finishing, protecting, cleaning and similar operations at the project site to complete items of work furnished by others.

## 1.03 ADDITIONAL REQUIREMENTS TO DIVISION 01

A. Operation and Maintenance Documentation: Provide copies of certificates of code authority acceptance, test data, product data, guarantees, warranties, and the like.

B. Shop Drawings: When requested by individual Sections provide shop drawings which include physical characteristics, electrical characteristics, device layout plans, wiring diagrams, and the like. Refer to individual Specification Sections for additional requirements for the shop drawings.

C. Closeout Documentation: Submit electrical code authority certification of inspection. Include documentation of on-site electrical testing that was performed.

D. Record Drawings:
1. Show changes and deviations from the Drawings. Include written Addendum and change order items.
2. Show exact routes of feeders 100 amp and larger; and service entrance conduits.
3. Show exact location of switchboards, distribution panelboards, safety disconnects, motor controllers, and the like.
4. Make changes to drawings in electronic format. Obtain electronic copy from Architect, use the same version of AutoCAD to prepare record drawings as was used by the Architect. Provide electronic copy and hard copy to Architect for review.
5. Provide a full size Record Drawing of the one-line power diagram sealed in a plastic coating. Mount on the wall of the electric room.

## 1.04 QUALITY ASSURANCE

A. Conform to requirements of the CEC, latest adopted version with amendments by local AHJs.

B. Conform to latest adopted version of the CBC with amendments by local AHJs.

C. Obtain and pay for electrical permits and inspections from local AHJs.

D. Furnish products listed by UL or other testing firm acceptable to AHJ.

## 1.05 SEQUENCING AND SCHEDULING

A. For the proper execution of the work cooperate with other crafts and contracts as needed.

B. To avoid installation conflicts, thoroughly examine the complete set of Contract Documents. Resolve conflicts with Engineer prior to installation.

C. Prior to installation of feeders to equipment requiring electrical connections, examine the manufacturer's shop drawings, wiring diagrams, product data, and installation instructions. Verify that the electrical characteristics detailed in the Contract Documents are consistent with the electrical characteristics of the actual equipment being installed. When inconsistencies occur request clarification from Engineer.

## PART 2 - PRODUCTS

### 2.01 MANUFACTURERS

A. Provide like items from one manufacturer, such as luminaire types, switches, receptacles, breakers, panels, and the like.

### 2.02 MATERIALS

A. Provide new electrical materials of the type and quality detailed, listed by UL, bearing their label wherever standards have been established. Indicated brand name and catalog numbers are used to establish standards of performance and quality. The description of materials listed herein governs in the event that catalog numbers do not correspond to materials described herein.

B. Provide material and equipment that is acceptable to AHJ as suitable for the use indicated. For example, provide wet labeled equipment in locations that are wet.

C. Include special features, finishes, accessories, and other requirements as described in the Contract Documents regardless of the item's listed catalog number.

D. Provide incidentals not specifically mentioned herein or noted on Drawings, but needed to complete the system, in a safe and satisfactory working condition.

### 2.03 FIRESTOPPING

A. Foam Sealant: Foam sealant for use around conduit penetrations to prevent passage of smoke, fire, toxic gas or water. Maintain seal before, during and after fire. In and around conduit for thermal break at penetration of barrier between heated and unheated spaces. Chase Technology Corporation, Fire Foam, Thomas & Betts, or approved.

## PART 3 - EXECUTION

### 3.01 EXAMINATION

A. Construction Documents:
   1. Drawings are diagrammatic with symbols representing electrical equipment, outlets, luminaires, and wiring.
   2. Electrical symbols indicating wiring and equipment shown in the Contract Documents are included in the Contract unless specifically noted otherwise.
   3. Examine the entire set of Drawings to avoid conflicts with other systems. Determine exact route and installation of electrical wiring and equipment with conditions of construction.

B. Clarification:
1. The Drawings govern in matters of quantity, the Specification in matters of quality. In event of conflict on Drawings or in the Specifications, the greater quantity and the higher quality apply.
2. Should the Electrical Documents indicate a condition conflicting with the governing codes and regulations, refrain from installing that portion of the work until clarified by Engineer.

## 3.02 INSTALLATION

A. Install electrical equipment complete as directed by manufacturer's installation instructions. Obtain installation instructions from manufacturer prior to rough-in of the electrical equipment, examine the instructions thoroughly. When requirements of the installation instructions conflict with the Contract Documents, request clarification from Engineer prior to proceeding with the installation.

B. Do not install electrical equipment in obvious passages, doorways, scuttles or crawl spaces which would impede or block the area passage's intended usage.

C. Noise Control:
1. Do not install outlet boxes back to back. Do not use straight through boxes.
2. Do not place contactors, transformers, starters and similar noise producing devices on walls which are common to occupied spaces unless specifically called for on Drawings. Where such devices must be mounted on walls common to occupied spaces, mount or isolate in such a manner as to effectively prevent the transmission of their inherent noise to the occupied space.

D. Firestopping:
1. Coordinate with the Drawings the location of fire rated walls, ceilings, floors and the like. When these assemblies are penetrated by electrical equipment, seal around the equipment with approved firestopping material.
2. Install firestopping material complete as directed per the manufacturer's installation instructions.

## 3.03 FIELD QUALITY CONTROL

A. Tests:
1. Conduct tests of equipment and systems to demonstrate compliance with requirements specified in Division 26. Refer to individual Specification Sections for required tests. Document tests and include in Closeout Documents.
2. During site evaluations by Engineer, provide an electrician with tools to remove and replace trims, covers, devices, and the like, so that a proper evaluation of the installation can be performed.

## 3.04 CLEANING

A. Remove dirt and debris caused by the execution of the electrical work.

B. Leave the entire electrical system installed under this Contract in clean, dust-free and proper working order.

C. Vacuum clean interiors of all new and modified electrical signal and communication equipment enclosures.

## 3.05 DEMOLITION

A. Coordinate with Owner so that work can be scheduled not to interrupt operations, normal activities, building access, access to different areas. The Owner will cooperate to the best of their ability to assist in a coordinated schedule, but will remain the final authority as to time of work permitted.

B. Examination: Determine the exact location of existing utilities and equipment before commencing work, compensate the Owner for damages caused by the failure to locate and preserve utilities. Replace damaged items with new material to match existing.

C. Promptly notify Owner if utilities are found which are not shown on Drawings.

D. Execution:
1. Remove existing luminaires, switches, receptacles, and other electrical equipment and devices and associated wiring from walls, ceilings, floors, and other surfaces scheduled for remodeling, relocation, or demolition unless shown as retained or relocated on Drawings.
2. Maintain electrical continuity of existing systems. Remove or relocate electrical boxes, conduit, wiring, equipment, luminaires, and the like, as encountered in removed or remodeled areas in the existing construction affected by this work.
3. Remove and restore wiring which serves usable existing outlets clear of the construction or demolition.
4. If existing junction boxes will be made inaccessible, or if abandoned outlets serve as feed through boxes for other existing electrical equipment which is being retained, provide new conduit and wire to bypass the abandoned outlets.
5. If existing conduits pass through partitions or ceiling which are being removed or remodeled, provide new conduit and wire to reroute clear of the construction or demolition and maintain service to the existing load.
6. Extend circuiting and devices in existing walls to be furred out.
7. Remove abandoned wiring to leave site clean.
8. If existing electrical equipment contains PCBs (polychlorinated biphenyl), replace with new. Dispose of material containing PCBs as required by federal and local regulations.
9. Repair adjacent construction and finishes damaged during demolition work.
10. Maintain access to existing electrical installations which remain active. Modify installation or provide access panel as appropriate.

## 3.06 CONTINUITY OF SERVICE

A. No interruption of services to any part of existing facilities will be permitted without express permission in each instance from the Owner. Requests for outages shall state the specific dates and hours and the maximum durations, with the outages kept to these specific dates and hours and the maximum durations. Obtain written permission from the Owner for any interruption of power, lighting or signal circuits and systems.

B. If overtime is necessary, there will be no allowance made by Owner for extra expense for such overtime or shift work, due to maintaining continuity of service herein required.

C. Organize work to minimize duration of power interruption.

**END OF SECTION**

# SECTION 26 01 00

# BASIC MATERIALS AND METHODS

## PART 1 - GENERAL

### 1.01 SUMMARY

A. Section Includes:
1. Raceways.
2. Wires, cables and connectors.
3. Outlet boxes.
4. Devices and plates.
5. Surface raceway system.
6. Identification.
7. Safety disconnect switches.

### 1.02 SYSTEM DESCRIPTION

A. Provide raceways, wires, cables, connector, boxes, devices, finish plates and the like for a complete and operational electrical system.

B. Electrical Connections: Connect equipment, whether furnished by Owner or other Divisions of the Contract, electrically complete.

C. Supporting Devices: Safety factor of 4 required for every fastening device or support for electrical equipment installed. Support to withstand four times weight of equipment it supports. Bracing to comply with Seismic Zone 4 requirements.

### 1.03 SUBMITTALS

A. Provide shop drawings and product data for the following:
1. Raceways.
2. Wires, cables and connectors.
3. Surface raceway system.
4. Identification equipment.
5. Safety disconnect switches.

B. Provide the following operating and maintenance instructions from the manufacturer for project closeout, see project closeout requirements in Division 01:
1. Devices and plates.
2. Safety disconnect switches.

### 1.04 REGULATORY REQUIREMENTS

A. Conform to requirements of the CEC, latest adopted version with amendments by local AHJs.

B. Furnish products listed by UL or other testing firm acceptable to AHJ.

## PART 2 - PRODUCTS

### 2.01 RACEWAYS

A. Conduits:
1. Galvanized Rigid Steel Conduit (GRC): Hot-dip galvanized after thread cutting. Manufacture in conformance with Federal Specification WWC-581 and ANSI C80.1.
2. Electrical Metallic Tubing (EMT): Hot-dip galvanized and chromate coated. Manufacture in conformance with Federal Specification WWC-563 and ANSI C80.3.
3. Flexible Conduit: Reduced wall flexible steel conduit. Hot-dip galvanized. Manufacture in conformance with Federal Specification A-A-55810.
4. Flexible Conduit, PVC Coated: Hot-dip galvanized steel. PVC chemical resistant jacket extruded to core, up to 1-inch trade size. PVC chemical resistant jacket, tubed over core, up to 4-inch trade size.

B. Conduit Fittings:
1. Bushings: Malleable iron with plastic insulator lining, 150C rated.
2. Ground Bushings: Malleable iron with plastic insulating liner and aluminum grounding lug rated for copper or aluminum conductor, 150C rated.
3. EMT Connectors and Couplings: Compression Type: Zinc plated steel, insulated throat connectors, raintight up to 2 inches.
4. Rigid Steel Conduit Ells: PVC coated or painted with No. 51 bitumastic material, long radius ells, minimum radius of 36 inches.
5. Expansion/Deflection Fittings:
   a. EMT: Use O-Z Gedney Type TX.
   b. GRC: Use O-Z Gedney Type AX, DX and AXDX.

### 2.02 WIRES AND CABLES

A. Copper, 600 volt rated throughout. Conductors 14AWG to 10AWG, solid. Conductors 8AWG and larger, stranded. Phase color to be consistent at feeder terminations; A-B-C, top to bottom, left to right, front to back. Conductors 3AWG and larger, minimum insulation rating of 75C. Insulation types THWN, THHN or XHHW. Minimum insulation rating of 90C for branch circuits. Color code conductors as follows:

| PHASE | 208 VOLT WYE | 240 VOLT DELTA | 480 VOLT |
|---|---|---|---|
| A | Black | Black | Brown |
| B | Red | Orange (High Leg) | Orange |
| C | Blue | Blue | Yellow |
| Neutral | White | White | Gray |
| Ground | Green | Green | Green |
| Isolated Ground | Green w/yellow trace | N/A | N/A |

B. Service Entrance Cable: Copper conductor, 600 volt insulation, XHHW, Type SE.

### 2.03 CONNECTORS

A. Copper Pads: Drilled and tapped for multiple conductor terminals.

B. Lugs: Indent/compression type for use with stranded branch circuit or control conductors. Manufacturers: Anderson, Ilsco, Panduit, Thomas & Betts, 3M, or approved.

C. Conductor Branch Circuits: Wire nuts with integral spring connectors for conductors 18 through 8AWG. Push-in type connectors where conductors are not required to be twisted together are not acceptable. Manufacturers: 3M, Ideal, or approved.

## 2.04 BOXES

A. Accessories: Provide outlet box accessories as required for each installation, including mounting brackets, wallboard hangers, extension rings, luminaire studs, cable clamps and metal straps for supporting outlet boxes, compatible with outlet boxes being used and meeting requirements of individual wiring situations.

B. Weatherproof Outlet Boxes: Provide corrosion-resistant cast metal weatherproof outlet wiring boxes, of the type, shape and size, including depth of box, with threaded conduit ends, cast metal face plate with spring-hinged waterproof cap suitably configured for each application, including face plate gasket, blank plugs and corrosionproof fasteners. Weatherproof boxes to be constructed to have smooth sides, gray finish. Bell, Carlon, Red Dot, or approved.

C. Junction and Pull Boxes: Provide ANSI 49 gray enamel painted sheet steel junction and pull boxes, with screw-on covers; of the type shape and size, to suit each respective location and installation; with welded seams and equipped with steel nuts, bolts, screws and washers. Circle AW, Hoffman, or approved.

D. Box Extension Adapter: Die-cast aluminum construction. Install over flush wall outlet boxes to permit flexible raceway extension to equipment. Bell 940 Series, Carlon, Red Dot IHE4 Series, or approved.

E. Conduit Fittings: Provide corrosion-resistant punched-steel box knockout closures, conduit locknuts and plastic conduit bushings of the type and size to suit each respective use and installation. O-Z Gedney, Thomas & Betts, or approved.

## 2.05 WIRING DEVICES

A. Wall Switches: Toggle Type Characteristics: Quiet acting, 20 amp, 120/277 volt, UL listed for motor loads up to 80 percent of rated amperage. Cooper 1221, Leviton 1221, Hubbell 1221, Pass & Seymour 20ACI.

B. Receptacles:
1. Finish: Same exposed finish as switches.
2. Duplex Receptacle Characteristics: Straight parallel blade, 125 volt, 2 pole, 3 wire grounding. Industrial Grade: Back and side wired. Single piece, rivetless. Brass grounding system and mounting strap. 20 amp. Cooper 5362, Hubbell 5362, Leviton 5362A, Pass & Seymour 5362A.
3. Ground Fault Circuit Interrupter (GFCI) Receptacle: Meets or exceeds UL943 (Class A GFCI), UL498. Feed through type, back-and-side wired, 20 amp, 125VAC, Cooper XGF20, Hubbell GF5362, Leviton 8898, Pass & Seymour 2094.
4. UL Wet-Listed Covers While-In-Use: NEMA 3R when closed over energized plug. Vertical mount for duplex receptacle. Provide continuous use cover with cover capable of closing over energized cord cap with bottom aperture for cord exit. UV stabilized polycarbonate cover with closed cell neoprene foam gasket. Pass & Seymour WIUC10, Leviton 5977, Hubbell WP826MP, Cooper 4966.
5. Special Purpose Receptacles: Refer to drawings for NEMA Standard Specification.

C. Finish Plates: Match district standard.

D. Surface Covers:
1. Material: Galvanized or cadmium plated steel, 1/2-inch raised industrial type with openings appropriate for devices installed in surface outlets.
2. Cast Box and Extension Adaptors: Aluminum, with gasket, blank. One gang, Bell 240-ALF, Carlon; two gang, Bell 236-ALF, Carlon, or approved.

## 2.06 SURFACE RECEPTACLE/SIGNAL RACEWAY SYSTEMS

A. Two-Channel Surface Raceway: One channel for power, the other channel for signal. Provide 20 amp multi-circuit as indicated on drawings. Provide divider between channels. Wiremold V4000 Series, or approved.

B. Provide lengths taken from drawings to a tolerance of 1/2 inch over raceway length between end wall surface. Do not scale from Division 26 Drawings.

C. Provide prewired receptacles every 24 inches unless otherwise noted on drawings.

D. Provide endcaps, corner joints, tees, transition fittings, and the like, for a complete installation.

E. Verify exact mounting height with drawings.

F. Finish: Ivory.

## 2.07 SAFETY DISCONNECTS

A. Toggle Type Disconnect Switches: 120 volt, 1 pole, 20 amp, 1 HP maximum. NEMA 1 enclosure for indoors, NEMA 3R enclosure for outdoors.

B. Manual Motor Starters: Quick-make, quick-break. Thermal overload protection. Device labeled with maximum voltage, current and horsepower. Eaton Electrical, General Electric, Siemens, Square D Class 2510, or approved. Provide NEMA 1 enclosure for indoors, NEMA 3R enclosure for outdoors.

C. Safety Switches: Heavy duty, fused type, dual rated, quick-make, quick-break with fuse rejection feature for use with Class R fuses only, unless other fuse type is specifically noted. Provide NEMA 1 enclosure for indoors, NEMA 3R enclosure for outdoors. Switches clearly marked for maximum voltage, current and horsepower. Equip enclosure with defeatable cover interlock. Switches rated for maximum available fault current. Manufacturers: Eaton Electrical, General Electric, Siemens, Square D, or approved.

## 2.08 ELECTRICAL IDENTIFICATION

A. Engraved Labels: Melamine plastic laminate, white with black core, 1/16 inch thick, manufactured by Lamicoid. Engravers standard letter style, minimum 3/16-inch high letters, capitals. Drill or punch labels for mechanical fastening except where adhesive mounting is necessary because of substrate. Use self-tapping stainless steel screws.

B. Conductor Numbers: Manufacturers standard vinyl-cloth self-adhesive cable and conductor markers of the wraparound type. Preprinted black numbers on yellow field. Brady, Panduit, or approved.

C. Circuit Breaker Identification: Provide permanent identification number in or on panelboard or motor control center dead-front adjacent to each circuit breaker pole position.

## PART 3 - EXECUTION

### 3.01 ELECTRICAL CHARACTERISTICS

A. Verify electrical characteristics of equipment prior to installation of conduits and wiring for equipment. Coordinate HVAC voltage requirements with drawings and equipment submittals prior to rough in.

## 3.02 MOTOR BRANCH CIRCUIT WIRING

A. Do not install electrical equipment or wiring on mechanical equipment without approval of Architect.

B. Provide moisture tight equipment wiring and switches in ducts or plenums used for environmental air.

C. Connect motor branch circuits complete from panel to motor as required by code and manner herein described.

D. Motor starter, control devices and control wiring provided by other Divisions unless noted on drawings.

## 3.03 APPLIANCE/UTILIZATION EQUIPMENT

A. Provide appropriate cable and cord cap for final connection unless equipment is provided with same. Verify special purpose outlet NEMA configuration and ampere rating with equipment supplier prior to ordering devices and coverplates.

## 3.04 INSTALLATION

A. Conduit:
   1. Conduit Joints: Assemble conduits continuous and secure to boxes, panels, luminaires and equipment with fittings to maintain continuity. Provide watertight joints where embedded in concrete, below grade or in damp locations. Seal PVC conduit joints with solvent cement and metal conduit with metal thread primer. Rigid conduit connections to be threaded, clean and tight (metal to metal).
   2. Conduit Placement:
      a. Install continuous conduit and raceways for electrical power wiring and signal systems wiring.
      b. Conceal conduits. Exposed conduits are permitted only in the following areas:
         1) Mechanical rooms, electrical rooms or spaces where walls, ceilings and floors will not be covered with finished materials.
         2) Existing walls that are concrete or block construction.
         3) Where specifically noted on the drawings.
      c. Where exposed conduits are permitted install parallel or at right angles to building lines, tight to finished surfaces and neatly offset into boxes.
      d. Do not install conduits or other electrical equipment in obvious passages, doorways, scuttles or crawl spaces which would impede or block the area passage's intended usage.
      e. Do not install conduits on surface of building exterior, across roof, on top of parapet walls, or across floors.
      f. Route raceway at least 6 inches from hot surfaces above 120F, including noninsulated steam lines, heat ducts, and the like.
   3. Maximum Bends: Install code sized pull boxes to limit sum of bends in a run of conduit to 270 degrees.
   4. Flexible Conduit: Install 12-inch minimum slack loop on flexible metallic conduit and PVC coated flexible metallic conduit.
   5. Conduit Size: Size as indicated on drawings. Where size is not indicated, provide conduit in minimum code permitted size for THW conductors of quantity required for complete operation. Minimum trade size 1/2 inch.

6. Provide pull cord in empty conduits that exceed 10 feet in length or the total sum of bends exceed 90 degree radius.
7. Conduit Use Locations:
   a. Underground: PVC.
   b. Wet Locations, and areas subject to Mechanical Damage: GRC.
   c. Damp Locations and Locations Exposed to Rain: GRC and EMT up to 2 inches in diameter.
   d. Dry, Protected: GRC and EMT.
   e. Sharp Bends and Elbows: GRC, EMT use factory elbows.
   f. Install pull wire or nylon cord in empty raceways provided for other systems. Secure wire or cord at each end.
   g. Elbow for Low Energy Signal Systems: Use long radius factory ells where linking sections of raceway for installation of signal cable.
   h. Motors, recessed luminaires and equipment connections subject to movement or vibration, use flexible metallic conduit.
   i. Motors and equipment connections subject to movement or vibration and subjected to any of the following conditions; exterior location, moist or humid atmosphere, water spray, oil or grease use PVC coated liquid tight flexible metallic conduit.
8. Branch Circuits: Do not change the intent of the branch circuits or controls without approval. Homeruns for 20 amp branch circuits may be combined to a maximum of six current carrying conductors in a homerun. Apply derating factors as required by CEC. Increase conductor size as needed.
9. Feeders: Do not combine or change feeder runs.
10. Unless otherwise indicated, provide raceway systems for lighting, power and Class 1 remote-control and signaling circuits and Class 2 and 3 remote-control signaling and communication circuits.

B. Conduit Fittings:
1. Use compression fittings in dry locations, damp and rain-exposed locations. Maximum size permitted in damp locations and locations exposed to rain is 2 inches in diameter.
2. Use threaded type fittings in wet locations, and damp or rain-exposed locations where conduit size is greater than two inches.
3. Use insulated type bushings with ground provision at switchboards, panelboards, safety disconnect switches, junction boxes and the like that have feeders 60 amperes and greater.
4. Provide bushing or EMT connector for conduits that do not terminate in box, enclosure, or the like.
5. Provide conduit expansion fittings at building expansion joints and at locations where conduit is exposed to thermal expansion and contraction.
6. Condulets and Conduit Bodies: Do not use condulets and conduit bodies in conduits for signal wiring, in feeders 100 amp and larger.

C. Sleeves and Chases: Provide necessary rigid conduit sleeves, openings and chases where conduits or cables are required to pass through floors, ceiling or walls. Maintain integrity of fire-rated assemblies at penetrations of walls, ceilings or floors.

D. Conductors, Wires and Cables:
1. Conductor Installation: Install conductors in raceways having adequate, code size cross-sectional area for wires indicated. Install conductors with care to avoid damage to insulation. Do not apply greater tension on conductors than recommended by manufacturer during installation. Use of pulling compounds is permitted. Clean residue from exposed conductors and raceway entrances after conductor installation. Do not use pulling compounds for installation of conductors connected to GFCI circuit breakers or GFCI receptacles.
2. Conductor Size and Quantity: Install no conductors smaller than 12AWG unless otherwise shown. Provide required conductors for a fully operable system.
3. Provide dedicated neutrals (one neutral conductor for each phase conductor) in the following single phase circuits:
   a. Isolated ground circuits.
   b. Ground fault protected circuits where a GFCI breaker is used in a panelboard.
   c. Other electronic equipment that produces a high level of harmonic distortion including, but not limited to, computers, printers, plotters, copy machines, and fax machines.

E. Connectors: Retighten lugs and connectors for conductors to equipment prior to Substantial Completion.

F. Boxes:
1. Location: Locate boxes and conduit bodies so as to ensure accessibility of electrical wiring.
2. Round Boxes: Avoid using round boxes where conduit must enter through side of box, which would result in a difficult and insecure connection with a locknut or bushing on the rounded surface.
3. Anchoring: Secure boxes rigidly to the substrate upon which they are being mounted, or solidly embed boxes in concrete or masonry.
4. Special Application: Provide weatherproof outlets for locations exposed to weather or moisture.
5. Knockout Closures: Provide knockout closures to cap unused knockout holes where blanks have been removed.
6. Outlet System: Provide electrical boxes and fittings as required for a complete installation. Include but not limited to outlet boxes, junction boxes, pull boxes, bushings, locknuts, and other necessary components.
7. Code Compliance: Comply with CEC as applicable to construction and installation of electrical boxes and fittings and size boxes according to CEC, except as noted otherwise.
8. Flush Outlets in Finished Spaces: Maintain integrity of insulation and vapor barrier. Surface outlets are only acceptable in areas with surface conduit.
9. Mount center of outlet boxes as required by ADA, or noted on drawings, the following distance above the floor:
   a. Control Switches: 48 inches.
   b. Receptacles: 18 inches.
   c. Telecom Outlets: 18 inches.
   d. Other Outlets: As indicated in other Sections of Specifications or as detailed on drawings.
10. Coordinate electrical device locations (switches, receptacles, and the like) with drawings to prevent mounting devices in mirrors, back splashes, behind cabinets, and the like.

G. Wiring Devices:
1. Wall-Mounted Receptacles: Install with long dimension oriented vertically at centerline height shown on drawings or specified herein.
2. Vertical Alignment: When more than one outlet is shown on drawings in close proximity to each other, but at different elevations, align the outlets on a common vertical center line for best appearance. Verify with Architect.
3. GFCI Outlets: One GFCI receptacle may be used to provide GFCI protection to downstream duplex receptacles on the same branch circuit provided the following conditions are met:
   a. The downstream receptacles are in the same room as the upstream GFCI duplex receptacles, and
   b. The downstream duplex receptacles are labeled as being protected by an upstream GFCI receptacle in the same room.

H. Provide CEC-required disconnect switches whether specifically shown on drawings or not. Provide disconnect switch in sight of each motor location unless otherwise noted. Provide disconnect switch in site of each motor controller. Motor controller disconnect equipped with lock-out/tag-out padlock provisions do not require a disconnect switch at the controlled motor location. Coordinate fuse ampere rating with installed equipment. Fuse ampere rating variance between original design information and installed equipment, size in accordance with Bussmann Fusetron 40C recommendations. Do not provide fuses of lower ampere rating than motor starter thermal units.

I. Supporting Devices:
1. Verify mounting height of luminaires or items prior to installation when heights are not detailed.
2. Install vertical support members for equipment and luminaires, straight and parallel to building walls. Provide independent supports to structural member for electrical luminaires, materials, or equipment installed in or on ceiling, walls or in void spaces or over furred or suspended ceilings.
3. Do not use other trade's fastening devices as supporting means for electrical equipment, materials or luminaires. Do not use supports or fastening devices to support other than one particular item.
4. Support conduits within 18 inches of outlets, boxes, panels, cabinets and deflections. Maximum distance between supports not to exceed 8 foot spacing.
5. Securely suspend junction boxes, pull boxes or other conduit terminating housings located above suspended ceiling from the floor above or roof structure to prevent sagging and swaying.
6. Provide seismic bracing per CBC requirements for this building location.

J. Electrical Identification:
1. Graphics: Coordinate names, abbreviations and designations used on drawings with equipment labels.
2. Conductor Identification: Apply markers on each conductor for power, control, signaling and communications circuits.
3. Install an engraved label on each major unit of electrical equipment indicating both equipment name and circuit serving equipment (e.g. "EF-1, CKT. 2P1-1,3,5), including but not limited to the following items: Disconnect switches, relays, contactors, time switches, override switches, service disconnects, distribution switches, branch circuit panelboards, and central or master unit of each electrical system including communication/signal systems.
4. Install engraved labels on the inside of flush panels, visible when door is opened. Install label on outside of surface panel.

5. Install signs at locations detailed or, where not otherwise indicated, at location for best convenience of viewing without interference with operation and maintenance of equipment.

## 3.05 FIELD QUALITY CONTROL

A. Wiring Device Tests: Test wiring devices to ensure electrical continuity of grounding connections, and after energizing circuitry, to demonstrate compliance with requirements. Test receptacles for line to neutral, line to ground and neutral to ground faults. Correct any defective wiring.

B. Feeder Tests:
1. Test conductor insulation on feeders of 100 amp and greater for conformity with +1000 volt megohmeter. Use Insulated Cable Engineers Association testing procedures. Minimum insulation resistance acceptable is 1 megohm for systems 600 volts and below. Notify Architect if insulation resistance is less than 1 megohm.
2. Test Report: Prepare a typed tabular report indicating the testing instrument, the feeder tested, amperage rating of the feeder, insulation type, voltage, the approximate length of the feeder, conduit type, and the measured resistance of the megohmeter test. Submit report with operating and maintenance manual.

**END OF SECTION**

# SECTION 26 08 05

# ELECTRICAL ACCEPTANCE TESTING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
1. Testing, evaluation and calibration of equipment provided, installed and connected in Division 26.
2. Evaluation of connection and normal operation of utilization equipment, provided in other Divisions, for installation and connection in Division 26.

### 1.2 REFERENCES

A. Acceptance Testing Criteria: Latest edition of Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems, published by IETA.

B. Applicable Codes, Standards and References:
1. California Electrical Code (CEC).
2. National Electrical Manufacturer's Association (NEMA).
3. American Society for Testing and Materials (ASTM).
4. Institute of Electrical and Electronic Engineers (IEEE).
5. International Electrical Testing Association (IETA).
6. American National Standards Institute (ANSI).
7. State and local codes and ordinances.
8. Insulated Power Cable Engineers Association (IPCEA).
9. Association of Edison Illuminating Companies (AEIC).
10. OSHA Part 1910; Subpart S, 1910.308.
11. National Fire Protection Association (NFPA).

### 1.3 SYSTEM DESCRIPTION

A. Performance Requirements:
1. Retain the services of a recognized independent testing firm for the purpose of performing inspections and tests as specified herein.
2. Independent test firm providing report direct to Architect.
3. Material, equipment, labor and technical supervision to perform tests and inspections provided by testing firm.
4. It is the intent of these tests to assure that electrical equipment, Contractor or Owner supplied, is operational within industry and manufacturer's tolerances and is installed in accordance with design Specifications.
5. Tests and inspections determine suitability for energization.
6. Supply to the independent testing organization complete sets of approved shop drawings, coordination study (provided by Contractor's equipment supplier under Contractor's direction, setting of adjustable devices and other information requested by testing agency).

B. Scope of Testing, Evaluation and Calibration:
1. Distribution transformers.
2. Low voltage circuit breakers (greater than 100 amp).
3. Switchboards.
4. Ground fault protective signaling.
5. Grounding systems.
6. Motor control centers.

## 1.4 SUBMITTALS

A. Test Reports:
   1. Maintain written record of tests.
   2. At completion of project, assemble and certify a final test report. Submit report to Architect prior to final acceptance to include:
      a. Summary of project.
      b. Description of equipment tested.
      c. Visual inspection report.
      d. Description of tests.
      e. Test results.
      f. Conclusions and recommendations.

## 1.5 QUALITY ASSURANCE

A. Qualifications of Testing Firm:
   1. Corporately independent testing organization which can function as an unbiased testing authority, professionally independent of the manufacturers, suppliers and installers of equipment or systems evaluated by testing firms.
   2. Independent organization as defined by OSHA Title 29, Part 1936 and IETA.
   3. Regularly engaged in the testing of electrical materials, devices, appliances, electrical installations and systems for the purpose of preventing injury to persons or damage to property and other equipment.
   4. Engaged in testing practices for minimum of 2 years.
   5. Use only full-time technicians, regularly employed by firm for testing services. Electrically unskilled employees are not permitted to perform testing or assistance of any kind. Electricians and line workers may assist, but may not perform testing or inspection services.
   6. Submit proof of above qualifications with Bid Documents.

B. Certifications:
   1. Comply with OSHA criteria for accreditation of testing laboratories, Title 29, Parts 1907, 1910 and 1936. Full membership in the IETA constitutes proof of such criteria.
   2. Lead, on site, technical person currently certified by IETA in Electrical Power Distribution System Testing.
   3. Instruments used by testing firm to evaluate electrical performance meet IETA Specifications for Test Instruments.

# PART 2 - PRODUCTS (Not Used)

# PART 3 - EXECUTION

## 3.1 FIELD QUALITY CONTROL

A. Tests:
   1. Contractor's Responsibilities:
      a. Perform routine insulation resistance, continuity and rotation tests for distribution and utilization equipment prior to and in addition to tests performed by testing firm.
      b. Notify the testing firm when equipment becomes available for acceptance tests. Coordinate work to expedite project scheduling.
   2. Testing Firm's Responsibilities:
      a. Notify Architect prior to commencement of any testing.

b. Report directly to Architect any systems, material or installation found defective on the basis of acceptance tests.
c. Provide auxiliary portable power supply necessary for conducting tests.

## 3.2 ADJUSTING

A. Final Settings: Testing firm responsible for implementing final settings and adjustments on protective devices and tap changes in accordance with Architect's specified values.

**END OF SECTION**

# SECTION 26 09 15

# LIGHTING RELAY CONTROL PANEL

## PART 1 - GENERAL

### 1.1 INTRODUCTION

A. The work covered in this Section is subject to requirements in the General Conditions of the Specifications.

B. Coordinate the work in this Section with the trades covered in the other Sections of the Specification to provide a complete and operative system.

### 1.2 DESCRIPTION OF WORK

A. Extent of lighting control system work is indicated by drawings, and by the requirements of this section. It is defined to include lighting relay control panels, switch inputs, intertie to other building systems (fire alarm, security and energy management system for HVAC) and wiring.

B. Requirements are indicated elsewhere in these specifications for work including, but not limited to, raceways and electrical boxes and fittings required for installation of control equipment and wiring.

C. Basis of Design: Lighting relay panels on Drawings are designed based on PCI Lighting Litekeeper product line. Approved manufacturers listed below are allowed on condition of meeting the specified conditions including the available space for the equipment (including Code required working clearances). Remove and replace electrical equipment installed not meeting these conditions at no cost to Owner.

### 1.3 QUALITY ASSURANCE

A. Approvals:
1. Test the control panels and list under the UL 916 Energy Management Equipment standards.
2. CEC Compliance: Comply with applicable CEC regarding electrical wiring standards.
3. NEMA Compliance: Comply with applicable portions of the NEMA standards regarding the types of electrical equipment enclosures.
4. Component Pretesting: Control equipment shall undergo strict inspection standards. Previously test the equipment and burn-in at the factory prior to installation.

### 1.4 SUBMITTALS

A. Product Data: Submit manufacturer's data on lighting control system and components, including recommended spare parts list.

B. Shop Drawings: Submit drawings of lighting control panel and accessories including, but not necessarily limited to the riser diagram / system diagram, low voltage relay panels, power and communications wiring and termination, input/output schedules and sequence of operation for each control zone.

## 1.5 APPROVED MANUFACTURERS

A. Approved Manufacturers: PCI LiteKeeper 8, Leviton Lighting Controls, Douglas Lighting Controls, Intelligent Lighting Controls, Lighting Control & Design.

## PART 2 - PRODUCTS

## 2.1 MATERIALS AND COMPONENTS

A. System Description:
1. The lighting control system consists of low voltage relay control panels with 64 programmable switch inputs and up to 8 relays.
2. Each low voltage lighting control panel is microprocessor controlled. Accomplish programming through either the RS-232 port or through the network connection employing the Keeper Enterprise software or with an integral 2 x 16 – 32 character self-prompting LCD display and programming keypad.
3. Programmable intelligence includes time-of-day control, 32 holiday dates, a Warn Off to warn occupants of an impending OFF, timed inputs, preset control, auto daylight savings, astronomical clock w/offsets, and local control, digital switches and network overrides.
4. When control panel provides a Warn Off (flash the lights) to inform the occupants of an impending OFF command. The Warn Off command will allow 10 extra minutes for the occupants to override their lights or exit the premises.
5. Control panels permits lighting to be overridden ON for after-hours use or cleaning. Provide these overrides with hard-wired inputs or voice-guided touch-tone telephone control.
6. Control panel enclosures offer a maximum space of 8 relays.

## 2.2 HARDWARE FEATURES

A. Diagnostic Aids:
1. Each control panel shall incorporate diagnostic aids for confirmation of proper operation, or in case of failure these aids shall guide the individual in rapid troubleshooting of the system.
2. The control panels shall employ both a backlit LCD and LED's to indicate:
   a. POWER (LED).
   b. SYSTEM OK (LED).
   c. ON/OFF STATUS of EACH RELAY (LED & LCD).
   d. SYSTEM CLOCK AND DATE (LCD).
   e. PROGRAMMING CONFIRMATION (LCD).
3. Control systems that do not provide visual self-help diagnostics shall not be acceptable.

B. Status Indication of Relays: The system shall provide visible status indication of all relays through the window of each control panel. The visual indication shall disclose On/Off status and relay number. Systems that do not provide relay status while the enclosure door is closed shall not be acceptable.

C. Operator Interface: The control panel programming interface resides in firmware in the control panel. The programming interface shall consist of a circuit board mounted keypad and 2 line x 16 character LCD display. The integral keypad shall provide access to the main programming features. The keypad shall permit the user to manually command any or all relays individually. It shall also allow the user to link switch inputs and time schedules to relay outputs. Each panel shall control its own loads from internal memory. A control system that relies on a central control computer/processor or external time clocks shall not be permitted. Systems that utilize blocking diode technology for relay assignments shall not be acceptable.

D. Low voltage switches (Overrides): The controller shall provide timers for each low voltage switch (override). Each low voltage switch (override) timer shall be capable of 0-999 minutes. Software shall enable or disable low voltage switches (overrides) based on Priorities, Masks or Time of Day scheduling.

E. Digital Switch: The lighting controller shall support digitally addressable LED annunciated switches. The maximum total number of digital switches that may exist on the lighting control network is 16,320. Each Subnet shall support 64 buttons. The digital switch network requires CAT 5 cable between switches. The digital switches shall control any relay group combination on the PCI-Net lighting control network. Data communications status feedback for system checkout and troubleshooting (transmit and receive LED'S) shall be visible on the interface. The digital switch configuration system shall permit custom labeling for multiple button switch locations. The digital switch configuration shall be Decora® form and function.

F. Dry Contact Inputs: The control system shall permit 8 dry contacts inputs for override purposes. Support momentary 3 wire or 2 wire (toggle) inputs. Support maintained contacts as 2 wire (SPST) inputs. Inputs shall be dry contacts (24VDC at 12 ma. internally supplied to the inputs). The 24VDC power supply is provided with an auto-resettable fuse. Should an inappropriate electrical connection be made the design shall protect the board and switches until the fault is removed. Software link switch input to any number of relays for override control. The control panel shall have dry contact inputs on the logic board. Control systems that utilize separate accessories to allow for dry contact switches shall not be acceptable. Control systems that do not supply both digital switches and analog switches from the same controller shall not be permitted.

G. Photocell Control: The controller shall accept dry contact ambient light sensors. The controller shall provide power for the sensor thereby eliminating any external power supply. Sensors shall provide for outdoor and indoor applications and issue a command to the controller once the threshold is reached. The sensor shall provide user adjustable dead band control.

H. Remote Overrides: The controller shall accept remote commands issued from other inputs. The controller shall provide this feature without the need to add extra equipment to the controller. Remote overrides can be issued from the Telephone Interface Module (TIM), Photocells, Motion Sensors, Digital or Dry Contact Switches. Lighting systems that need to add extra equipment to receive remote overrides are not acceptable.

I. Service Override & Priority Override: The control panel shall provide a three position master-service override for the control unit. The service override shall not be accessible from the exterior. Systems that provide a service override on the exterior of the controller shall not be acceptable.

J. Modular Design:
1. The control system shall employ all modular connectors to avoid repeat wiring in case of component failure. Mount the system CPU board on quick-release spring pins that shall permit an entire change out of the processor and input board.
2. Connections for the switch inputs shall incorporate modular connectors. Provide modular relay board designed for rapid field replacement or upgrading. Systems that do not employ modular connectors shall not be acceptable.

K. Battery Back-up: The system shall utilize a memory back-up device that is system integrated and non-serviceable. Protect the data in RAM against power interruptions lasting as long as 10 years. Provide maintenance free power interrupt protection circuit.

L. Multi-tapped Transformer: The control panel incorporates the use of a multi-tapped transformer. The panel shall not require specification of voltage for each control location. The voltages of 120 and 277VAC available with each standard control panel.

M. Status Indication of Relays: The system shall provide visible status indication of all relays through the window of each control panel. The visual indication shall disclose ON/OFF status and relay number.

N. Service Override: The control panel shall provide a 3 position service override for the entire panel. The service override shall not be accessible from the exterior.

O. Lockable Enclosure: Enclose each control panel in a lockable NEMA Class 1 enclosure and shall provide pre-punched knockouts.

P. Relays: Electrically held 20amp 120/277VAC relays. Relays must be specified Normally Open or Normally Closed. Rate the relays for 10 million mechanical operations.
1. Standard Relay Module (SRM-NC): The system shall utilize normally closed control relays, which are rated to 20 amps at 120/277VAC. Magnetically hold the relays and provide on a card of eight relays per card. The wire terminations shall be able to accept 10 AWG. Rate the relays for 10 million mechanical operations. Provide a limited 10-year warranty on the individual relay cards. Systems that do not offer a limited 10-year warranty on all installations are not acceptable.
2. Latching Relay Card (LRC): The controller shall provide an option to provide latching relays that are rated to 20 amps at 347VAC. The relay shall provide an integral switch for both manual hand operation and visual indication of relay status. Rate the relays for 10 million mechanical operations. The wire terminations shall be able to accept 6 AWG wire. Provide a limited 10-year warranty on the individual relays. Systems that do not offer a limited 10-year warranty on all installations are not acceptable.
3. Latching Relay Card (LRC-RR7): The controller shall provide an option for remote placement of the control relays. A modular card shall connect into the relay compartment. Twisted (3) conductor cable shall power and control the remote mounted relays. Maximum distance is 500 feet employing 18 AWG conductor.
4. The following features shall be standard in the PC based software:
   a. Standard Software Features:
      1) Real Time Relay Status Monitoring.
      2) Alpha-Numeric Descriptors.
      3) Communications: Direct, TCP/IP and Modem.
      4) Status Indication.
      5) Global Software Modifications.
      6) Manual Relay Commands.
      7) Relay Pattern Commands.

8) Preset Options.
9) User Management – Password protection and privilege modification for multi-user security.
10) Logging of Controller Actions (switch inputs, TIM commands, & relay actuations).

b. File Maintenance
1) Archive Programs.
2) Data Base Restoration.
3) Uploading and Downloading of Programs.
4) Snap Shots — indication of changes and flawless panel restoration.

c. Software package shall permit the PC to be utilized for other functions (i.e. word processing, database, & etc.) besides lighting control. Systems that require an "on-line" dedicated computer for control system operation shall not be acceptable.

## PART 3 - EXECUTION

### 3.1 INSTALLATION AND DOCUMENTATION

A. Installation: Install the control system and fully wire as shown on the drawings by the installing contractor. Complete all electrical connections to all control circuits, and override wiring.

B. Documentation: Provide accurate "as-built" drawings to the owner for correct programming and proper maintenance of the control system. The "as-builts" shall indicate the load controlled by each relay and the relay panel number.

C. Operation and Service Manuals: The factory shall supply all operation and service manuals.

### 3.2 PRODUCT SUPPORT AND SERVICE

A. Factory Support: Factory telephone support shall be available at no cost to the owner. Factory assistance shall consist of solving programming or application questions concerning the control equipment.

### 3.3 SYSTEM ACCEPTANCE

A. Test to ensure that control devices, components, equipment and systems are calibrated, adjusted and operate in accordance with approved drawings and specifications.

B. Functionally test sequences of operation to ensure operation in accordance with approved drawings and specifications.

C. Prepare and complete report of test procedures and results and file with the Owner.

D. An operational user program shall exist in the control system. The program shall execute and perform all functions required to effectively operate the site according to the requirements.

E. Demonstration of program integrity during normal operation and pursuant to a power outage.

F. Provide a minimum of 4 hours training on the operation and use of the control system.

G. Lighting System Control Testing and Commissioning:
   1. Test lighting controls to ensure that control devices, components, equipment and systems are calibrated, adjusted and operate in accordance with Drawings and Specifications. Provide functional testing of sequences of operation to ensure operation in accordance with Drawings and Specifications. Provide complete report of test procedures and results to engineer and insert approved copy into project closeout documents.
   2. Testing shall include:
      a. Occupant sensing automatic controls.
      b. Automatic time and override controls for interior lighting.
      c. Automatic time and photo controls for exterior lighting.

## 3.4 WARRANTY

A. Warranty: Manufacturer shall supply a 3-year warranty on all hardware and software. Systems that provided special warranties based on installation shall not be acceptable.

**END OF SECTION**

# SECTION 26 09 21

# OCCUPANCY SENSORS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
1. Occupancy sensors.
2. Combined occupancy sensor/wall switches ("sensor/switches").
3. Automatic switches.

### 1.2 SYSTEM DESCRIPTION

A. Provide occupancy sensors to sense the presence of human activity within the desired space and enable or disable the on/off manual lighting control function provided by local switches.

B. Upon detection of human activity by the detector, sensor initiates a time delay to maintain the lights on for a preset period of time. Field adjustable time delay setting from 30 seconds to 15 minutes.

C. Factory set sensors for maximum sensitivity.

D. LED lamp built into sensor indicates when occupant is detected.

E. Provide zero cross relay control with sensors and sensor/switches; relay contacts close and open when AC voltage signal is at zero.

F. Where line voltage sensors and sensor/switches are used, provide to match voltage of controlled circuit.

G. Line Voltage Sensors, Control Units, and Relays: UL listed.

### 1.3 SUBMITTALS

A. Provide, on reproducible architectural floor plan, a layout of sensors indicating their sensing distribution.

B. Provide wiring diagrams indicating low voltage and line voltage wiring requirements.

## PART 2 - PRODUCTS

### 2.1 OCCUPANCY SENSORS (CEILING MOUNTED)

A. Passive Infrared Sensors:
1. Sensor Function: Detects human presence in the floor area being controlled by detecting changes in the Infrared energy. Sensor detects small movements, i.e., when a person is writing while seated at a desk.
2. Provide a temperature compensated dual element pyro-electric sensor and with multielement Fresnel lens.

3. Sensor utilizes DIP switches for adjustment to time delay and override. Field adjustable settings for sensitivity.
4. Provide a daylight filter to ensure that the sensor is insensitive to short-wavelength infrared waves, i.e., those emitted by the sun.
5. Conceal adjustments and mounting hardware under a removable cover to prevent tampering with adjustments and hardware.
6. Sensor utilizes advanced digital signal processing technology to reduce false offs without reducing sensitivity.
7. Ceiling-Mounted Sensor:
   a. 360 degree sensor range; coverage: 1200 square feet, unless otherwise noted on Drawings.
   b. Low Voltage Sensor: 24VDC power. Sensor operates remote power switch packs. Multiple sensors can be wired in parallel allow coverage of large areas.
   c. Manufacturers: Watt Stopper CI-300 Series, or approved.

B. Ultrasonic Occupancy Sensors:
1. Sensor Function: Detects human presence in the controlled floor area by detecting Doppler shifts in 40kHz ultrasound created by sensor.
2. Sensors are precision crystal controlled and do not interfere with each other when two or more are placed in the same area. Sensor includes advanced digital signal processing to reduce false on signals without decreasing sensitivity, as well as immunity to RFI/EMI sources.
3. Depluggable terminal for plug-and-play replacement.
4. Sensor utilizes DIP switches for adjustment to time delay and override. Field adjustable settings for sensitivity.
5. Low Voltage Sensor: 24VDC power. Sensor operates remote power switch packs. Multiple sensors can be wired in parallel allow coverage of large areas.
6. Ceiling-Mounted Sensor:
   a. Maximum protrusion of 1.1 inches and blend in aesthetically with the ceiling.
   b. Coverage: 360 degree sensor range; coverage: 2,000 square feet, unless otherwise noted on Drawings.
   c. Manufacturers: The Watt Stopper UT Series, or approved.
7. Ceiling Mounted Sensor – Hallway Sensor Coverage:
   a. Maximum protrusion of 1.5 inches and blend in aesthetically with the ceiling.
   b. Coverage: 90 lineal feet.
   c. Manufacturers: The Watt Stopper WT-2250 Series, or approved.

C. Dual Technology Sensors:
1. General: Sensor has combined capability of passive infrared and ultrasonic sensors as described above.
2. Function: Upon a person entering a space, motion must be sensed by both technologies before lighting will be turned on. After this has occurred, detection by either technology will hold lighting on for the set time period. Sensor shall have a retrigger time delay where only one motion is necessary to turn on the lights within 5 seconds after turning off.
3. Ceiling-Mounted Sensor:
   a. 360 degree sensor range; coverage: 1000 square feet for half-step motion, unless otherwise noted on Drawings.
   b. Low Voltage Sensor: 24VDC power. Sensor operates remote power switch packs. Multiple sensors can be wired in parallel allow coverage of large areas.
4. Manufacturers: Watt Stopper DT-300 Series, or approved.

## 2.2 COMBINED OCCUPANCY SENSOR/WALL SWITCHES ("SENSOR/SWITCHES")

A. Completely self-contained sensor system that fits into a standard single gang box. Internal transformer power supply, latching dry contact relay switching mechanism compatible with electronic ballasts, compact fluorescent, and inductive loads. Triac and other harmonic generating devices are not allowed.

B. Passive infrared sensor technology includes advanced signal processing to reduce false triggers without increasing sensitivity.

C. Rated to switch loads: 800 watts incandescent or 120-volt ballast; 1000 watts 277 volt ballast.

D. Provide adjustable daylight feature that holds lighting "off" when a desired footcandle level is present.

E. Provide integral off override switch with no leakage current to the load or ground.

F. Provide hard 1mm poly IR2 lens; soft lens is not acceptable.

G. Alerts for impending shut-off: light flash, audible, both or none.

H. Standard Sensor/Switch:
1. 180 degree sensor range; coverage: 150 square feet for desktop activity.
2. Manufacturers: The Watt Stopper WA-200 Series, or approved.

I. Digital Timer Switch:
1. Controls up to 1800 watts at 120 volt, 4100 watts at 277 volt, suitable for ballast and motor loads.
2. Compatible with Decora style faceplate.
3. Provide low voltage (24VAC/VDC) version where used as input to lighting relay panel; includes single-pole, double-throw isolated relay rated for 1A at 30VDC.
4. Electroluminescent LCD display shows timer countdown.
5. Time out setting range from five minutes to 12 hours. Lights can be turned off before the time-out setting by holding down the on/off button.
6. Timer countdown can be reset to beginning by holding down push button for 2 seconds.
7. Zero crossing circuitry.
8. Room lighting flashed and switch beeps 5 minutes and 1 minute prior to switching room lighting off. Either visible or audible features can be disabled.
9. Manufacturers: Wattstopper TS-400 Series, or approved.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. Install occupancy sensors as directed by manufacturer's instructions. Provide connections to control circuits, occupancy sensors, power supply pack and low voltage wiring.

B. Drawings were laid out using Watt Stopper sensors as the basis of design. If another manufacturer is approved for installation under this Contract, verify with manufacturer representative that sensors are laid out to provide coverage across room space, adding additional sensors as needed.

C. Provide power packs for the sensor to control the number of circuits and/or switch legs within its area of coverage.

D. Field adjust each sensor to maximize its coverage of the room space.

E. Relocate sensors with ultrasonic technology to avoid being closer to HVAC diffusers and power packs than recommended by manufacturer.

F. Field set time delay for each device as noted below:
1. Classrooms and Conference Rooms: 30 minutes.
2. Restrooms: 30 minutes.
3. Storage Rooms, Janitor's Closets, Unisex Restrooms: 5 minutes.
4. All Other Spaces: 15 minutes.
5. Timer Switches: two hours.

## 3.2 QUALITY CONTROL

A. Use manufacturer's published testing and adjusting procedures to adjust sensors time delay, daylight sensitivity, and passive infrared sensitivity to satisfaction of the Owner.

B. Prepare and complete report of test procedures and results. Submit these test procedures and results to Owner and Architect.

**END OF SECTION**

# SECTION 26 20 00

# LOW VOLTAGE ELECTRICAL DISTRIBUTION

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
1. Grounding.
2. Switchboards.
3. Dry-type transformers.
4. Power distribution panelboards.
5. Lighting and appliance branch panelboards.
6. Overcurrent protection devices.

### 1.2 SYSTEM DESCRIPTION

A. Basis of Design: Switchboards, dry-type transformers, and power distribution panelboards, on Drawings are designed based on Square D product line. Approved manufacturers listed below are allowed on condition of meeting the specified conditions including the available space for the equipment (including Code required working clearances). Remove and replace electrical equipment installed not meeting these conditions at no cost to Owner.

### 1.3 SUBMITTALS

A. Provide Shop Drawings and Product Data for the Following Equipment:
1. Grounding.
2. Switchboards.
3. Dry-type transformers.
4. Power distribution panelboards.
5. Lighting and appliance branch panelboards.
6. Overcurrent protection devices.

B. Provide operating and maintenance instructions from the manufacturer for project closeout, see Project Closeout Requirements in Division 01.
1. Switchboards.
2. Dry-type transformers.
3. Power distribution panelboards.
4. Lighting and appliance branch panelboards.
5. Overcurrent protection devices.

### 1.4 REGULATORY REQUIREMENTS

A. Conform to requirements of the CEC, latest adopted version with amendments by local AHJs.

B. Furnish products listed by UL or other testing firm acceptable to AHJ.

C. Conform to SMCCD requirements and standards

## PART 2 - PRODUCTS

### 2.1 GROUNDING MATERIALS

A. Grounding Connectors: Hydraulic compression tool applied connectors or exothermic welding process connectors or powder actuated compression tool applied connectors. Mechanical type of connectors are not acceptable. Manufacturers: Burndy Hyground Compression System, Erico/Cadweld, Amp Ampact Grounding System, or approved.

B. Grounding Electrode Conductor: Bare copper stranded conductor.

### 2.2 DRY-TYPE TRANSFORMERS

A. Manufacturers: Eaton Electrical, Federal Pacific, General Electric, Jefferson Electric, Siemens, Square D, Controlled Power Co., or approved.

B. Voltage: Unless otherwise indicated on Drawings, operate transformers at 3 phase, nominal 480VAC delta primary to 3 phase 120/208VAC wye secondary. Provide standard NEMA, ANSI 3 phase primary taps; that is, 10 percent range of tap voltage adjustment for transformers smaller than 30KVA and 15 percent range tap voltage adjustment for 30KVA and larger.

C. Maximum temperature rise at full load: 150 degrees above 40C ambient temperature. NEMA TP-1 compliant.

D. Provide transformer coils of the continuous wire wound construction and impregnate with non-hygroscopic, thermosetting varnish prior to baking.

E. Visibly ground the core of the transformer to enclosure by means of a flexible ground strap.

F. Mount transformers, core and coil, on vibration mounting pads designed to suppress transmission of 120-cycle frequencies and harmonics thereof. Arrange and select pads in consideration of core and coil weight.

G. Transformer Supports: Provide vibration isolation hangers and pads, brackets and supports for a complete installation.

H. Lugs: Provide mechanical type lugs for conductor terminations.

### 2.3 SWITCHBOARDS

A. Manufacturers: Square D, Eaton Electrical, General Electric, Siemens, or approved.

B. Standards: Comply with requirements of UL 891 and NEMA PB2 in construction of switchboards. Provide short circuit current rating (Integrated Equipment Rating, IER) for panelboards. Furnish panelboards with UL label.

C. Enclosure: Free standing, dead front with front accessibility. Framework constructed of formed, code gauge steel, rigidly welded and bolted together to support cover plates, bussing and component devices during shipment and installation bolt steel base channels to the frame to rigidly support the entire shipping section for moving on rollers and floor mounting. Provide each section with individually removable top plate and open bottom to permit installation and termination of service and feeder raceways. Provide full height barriers between sections.

D. Bussing: Plated copper. Bus supports, connections and joints bolted together with hex-head bolts and Belleville washers. Full length of switchboard ground bus, 50 percent of phase bus capacity.

E. Provide fully rated integrated equipment rating greater than the available fault current. Series rated switchboards are not acceptable. See Drawings for available fault current. If Drawings do not have the available fault currents, then coordinate with serving electric utility.

F. Lugs: Mechanical type rated for both aluminum and copper conductors.

G. Provide provisions for metering per District Standard via Utility Vision Metering system.

## 2.4 LIGHTING AND APPLIANCE BRANCH PANELBOARDS

A. Manufacturers: Eaton Electrical, General Electric, Siemens, Square D, or approved.

B. Enclosures:
1. Flush Panelboards Rated 400 Amp or Less: Maximum enclosure depth, 5-3/4 inches.
2. Wiring Gutter Size: five inches at sides, six inches top and bottom.
3. Finish: Galvanized steel constructed in accordance with UL 50 requirements. Front shall have ANSI 49 gray enamel electrodeposited over cleaned phosphatized steel.
4. Hinged door with door-in-door construction, flush lift latch and lock, two keys per panel. Key panelboards alike.

C. Interior:
1. Copper bar with suitable electroplating (tin) for corrosion control at connection.
2. Provide copper ground bar to accommodate specified terminal lugs.
3. Predrill bus for bolt-on type circuit breakers.
4. Provide double lugs or landing pads for feed through feeders.
5. Provide feed through feeder lugs for field connection of multi-section flush panel sections, where applicable.
6. When distribution panel is feeding isolated ground circuits, provide isolated ground bar, insulated from panelboard enclosure, to accommodate specified terminal lugs.
7. Provide fully rated integrated equipment rating greater than the available fault current. See drawings for available fault current. Minimum rating is 10,000 amps rms symmetrical for 208 volt panelboards; 22,000 amps rms symmetrical for 480 volt panelboards.
8. Lugs: Mechanical type rated for both aluminum and copper conductors.
9. Provide interior wiring diagram, neutral wiring diagram, UL listed label and short circuit current rating on the interior or in a booklet format inserted in a sleeve inside the panel cover.

D. Main Circuit Breaker, Where Applicable: UL listed to accept solid or stranded copper conductors. Lugs suitable for 90C rated wire sized according to the 75C temperature

rating per CEC.

E. Branch Circuit Breakers:
1. Bolt-on type bus connectors.
2. UL listed to accept solid or stranded copper conductors. Lugs suitable for 90C rated wire sized according to the 75C temperature rating per CEC.
3. UL listed for use with the following factory installed accessories: Shunt trip, auxiliary switch and alarm switch.
4. UL listed with the following ratings:
   a. 15 to 125 amp breakers: Heating, Air Conditioning, and Refrigeration (HACR).
   b. 15 to 30 amp breakers: High Intensity Discharge (HID) lighting.
   c. 15 to 20 amp breakers: Switch Duty (SWD).

## 2.5 Power Distribution Panelboards

A. Manufacturers: Eaton Electrical, General Electric, Siemens, Square D, or approved.

B. Enclosures:
1. Provide boxes with removable blank end walls and interior mounting studs. Provide interior support bracket for ease of interior installation.
2. Finish: Galvanized steel constructed in accordance with UL 50 requirements. Front shall have ANSI 49 gray enamel electrodeposited over cleaned phosphatized steel.
3. Hinged door with door-in-door construction, flush lift latch and lock, two keys per panel. Key panelboards alike.

C. Interior:
1. Copper bar with suitable electroplating (tin) for corrosion control at connection.
2. Provide copper ground bar to accommodate specified terminal lugs.
3. Panelboard Interior: Three flat bus bars stacked and aligned vertically with glass reinforced polyester insulators laminated between phases. Molded polyester insulators shall support and provide phase isolation to entire length of bus.
4. Predrill bus for bolt-on type circuit breakers.
5. Provide double lugs or landing pads for feed through feeders.
6. Provide feed through feeder lugs for field connection of multi-section flush panel sections.
7. When distribution panel is feeding isolated ground circuits, provide isolated ground bar, insulated from panelboard enclosure, to accommodate specified terminal lugs.
8. Fully equip unused spaces for future devices, including manufacturer required connectors and mounting hardware.
9. Provide fully rated integrated equipment rating greater than the available fault current. See drawings for available fault current. If drawings do not have the available fault currents, then coordinate with serving electric utility. Minimum rating is shown on plans.
10. Lugs: Mechanical type rated for both aluminum and copper conductors.
11. Provide interior wiring diagram, neutral wiring diagram, UL listed label and short circuit current rating on the interior or in a booklet format inserted in a sleeve inside the panel cover.

## 2.6 OVERCURRENT PROTECTION DEVICES

A. Molded Case Circuit Breakers:
1. 1-, 2-, or 3-pole bolt-on, single-handle common trip, 600VAC or 250VAC as indicated on Drawings.
2. Overcenter toggle-type mechanism, quick-make, quick-break action. Trip

indication is by handle position.

3. Calibrate for operation in 40C ambient temperature.
4. 15 to 150 Amp Breakers: Permanent trip unit containing individual thermal and magnetic trip elements in each pole.
5. 151 to 400 Amp Breakers: Variable magnetic trip elements. Provide push-to-trip button on cover of breaker for mechanical tripping.
6. Greater than 401 Amp: Electronic trip type with adjustments for long-time, instantaneous, and short-time functions. Provide ground fault function for breakers greater than 400 amps.
7. Manufacturers: Square D, Eaton Electrical, General Electric, Siemens, or approved.

## 2.7 COMBINATION STARTERS

A. Heavy-duty, fused type, dual-rated, quick-make, quick-break with fuse rejection feature for use with Class R fuses only, unless other fuse type is specifically noted.

B. Enclosures NEMA 1 indoors, NEMA 3R raintight outdoors.

C. Clearly mark switches for maximum voltage, current and horsepower.

D. Provide coil voltage coordinated with control requirements.

E. Provide thermal overload units sized to equipment nameplate rating.

F. Provide one N.C. and one N.O. auxiliary contacts.

G. Provide prewired hand/off/auto switch and start button.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. Raceway Grounding:
1. Ground metallic raceway systems. Bond to ground terminal with code size jumper except where code size or larger grounding conductor is included with circuit, use grounding bushing with lay-in lug.
2. Connect metal raceways, which terminate within an enclosure but without mechanical connection to the enclosure, by grounding bushings and ground wire to the grounding bus.
3. Where equipment supply conductors are in flexible metallic conduit, install stranded copper equipment grounding conductor from outlet box to equipment frame.
4. Install equipment grounding conductor, code size minimum unless noted on Drawings, in metallic raceway systems.

B. Feeders and Branch Circuits Grounding:
1. Provide separate, equipment grounding insulated conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing.
2. Where installed in a continuous solid metallic raceway system and larger sizes are not detailed, provide insulated equipment ground conductors for feeders and branch circuits sized in accordance with Table 250.122.

C. Boxes, Cabinets, Enclosures and Panelboards Grounding: Bond grounding conductors to enclosure with specified conductors and lugs. Install lugs only on thoroughly cleaned contact surfaces.

D. Motors, Equipment and Appliance Grounding: Install code size equipment grounding conductor from outlet box to (motor) equipment frame or manufacturer's designated ground terminal.

E. Receptacle Grounding: Connect ground terminal of receptacle to equipment ground system by No. 12 conductor bolted to outlet box except isolated grounds where noted. Self grounding nature of receptacle devices does not eliminate conductor bolted to outlet box.

F. Telecommunications Grounding System: Mount telecommunications main grounding busbar (TMGB) in each IDF. Mount a telecommunications grounding busbar (TGB) in each IDF. Install main telecommunications bonding backbone (TBB) conductor continuous from the MDF to every IDF. Bond the TMGB to the main building electrical grounding system and the nearest acceptable structural ground with a 3/0 AWG copper equipment grounding conductor.

G. Separately Derived Systems: Ground each separately derived system.

H. Switchboards:
1. Install as directed by manufacturer's installation instructions.
2. Install equipment in conformance with work space requirements of CEC.
3. Locate equipment in rooms or spaces dedicated to such equipment, CEC. Coordinate with other divisions of work.
4. Provision for Future: Where provision for "future" or "space" is noted on Drawings, equip the space with bus connections to the future overcurrent device with suitable insulation and bracing to maintain proper short circuit rating and physical clearance. Provide buses for the ampere rating as shown for the future device.

I. Panelboards (Power Distribution Panelboards and Lighting and Appliance Branch Panelboards):
1. Install panelboards as directed by manufacturer's installation instructions.
2. Measure steady state load currents at each panelboard feeder; rearrange circuits in the panelboard to balance the phase loads to within 20 percent of each other. Maintain proper phasing for multi-wire branch circuits.
3. Install panelboards surface or flush mounted in accessible locations as indicated on drawings. Maintain or exceed minimum clearances required by code.
4. Where flush panels are installed, verify available recessing depth and coordinate wall framing with other divisions.
5. Feeder conductors to enter directly in line with lug terminals wherever practicable. Feeder conductors, except ground and neutral, not to exceed 45 degree deflection from raceway entry to feeder phase lugs.
6. Where panels are installed flush, provide 3/4-inch spare conduits from panel to accessible space above.
7. Where panels are installed flush in fire rated walls maintain fire rating of wall.
8. Surface panels to have metal trim covers with no sharp edges or corners. Surface panel enclosure finish to match trim cover.
9. Where two or more panels are installed side-by-side, provide covers of same height with each trim independently removable without disturbing the other sections.

10. Where panels are mounted in finished interior areas in normal view of the building occupants, paint covers to match adjacent wall surface.
11. Provision for Future: Where provision for "future" or "space" is noted on Drawings, equip the space with bus connections to the future overcurrent device with suitable insulation and bracing to maintain proper short circuit rating and physical clearance. Provide buses for the ampere rating as shown for the future device.

J. Control Devices:
1. Install time switches and other automatic control devices in accessible locations near the source of power or grouped at a common location in mechanical rooms or similar spaces.
2. Install photoelectric control devices at such locations as necessary to be most effective. Avoid locating photoelectric devices in or at locations where they can be influenced by other than natural light or under eaves. Verify location of equipment with Architect.

K. Dry-Type Transformers:
1. Comply with other applicable Sections of this Specification. Transformers up to 45KVA may be floor-mounted, wall-mounted or suspended where so indicated on Drawings. Floor-mount transformers above 45KVA rating.
2. Provide transformers with concrete working or housekeeping pad minimum 8 inches larger than transformer and minimum three inches above finish grade. Install plumb and level.
3. Do not mount transformers closer to combustible materials than allowed by CEC. Provide adequate ventilation, mount transformers away from adjacent surfaces as recommended by manufacturer.
4. Mount transformers on vibration isolating pads suitable for isolating the transformer housing from building structure.
5. Use flexible conduit, 18 inch minimum length, for connections to transformer case. Make connections to side panel or bottom of enclosure. Include ground conductor in flex.
6. Provide seismic restraints per local requirements.
7. Mount wall-mounted transformers with a minimum of 6 feet 6 inches of headroom below unit.
8. Field Quality Control:
   a. Check for damage and tight connections prior to energizing transformers.
   b. Measure primary and secondary voltages and make appropriate tap adjustments.
   c. Revise the installation of noisy units to achieve an acceptable noise level or replace with a new unit with an acceptable sound level.

L. Exterior Lighting Control: Control exterior lighting and interior atrium lighting using photoelectric switches to energize contactors controlling lighting circuits. Time clocks used to de-energize lighting at any preset time if desired.

## 3.2 CLEANING

A. Thoroughly clean the exterior and the interior of each switchboard and distribution panelboard in accordance with manufacturer's installation instructions.

B. Vacuum construction dust, dirt and debris out of each switchboard and distribution panelboard.

C. Where enclosure finish is damaged, touch up finish with matching paint in accordance with manufacturer's specifications and installation instructions.

## 3.3 TESTING

A. Test to ensure that control devices, components, equipment and systems are calibrated, adjusted and operate in accordance with approved drawings and specifications.
   1. Daylight sensing automatic lighting controls.
   2. Occupant sensing automatic lighting controls.
   3. Automatic time switches for lighting control.

B. Functionally test sequences of operation to ensure operation in accordance with approved drawings and specifications.

C. Prepare and complete report of test procedures and results and file with the Owner.

**END OF SECTION**

# SECTION 26 27 13

# ELECTRICITY METERING AND MONITORING

## PART 1 - SUMMARY

**1.1 All New Buildings and completely retrofitted buildings, as defined by the District, shall incorporate UtilityVision Panels and meters into their design for the monitoring of the utility usage for the building.**

## PART 2 - GENERAL

### 2.1 RELATED DOCUMENTS

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

### 2.2 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. FMC: Flexible metal conduit.

C. RNC: Rigid nonmetallic conduit.

### 2.3 SUBMITTALS

A. Product data for metering equipment.

### 2.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

## PART 3 - PRODUCTS

### 3.1 RACEWAYS AND WIRING

A. Raceways and wiring shall comply with Division 26 00 00 unless otherwise specified herein:
1. Wire insulation shall be 600 volt, Type THW or THHN.
2. Line voltage shall be #12 or larger.
3. Low Voltage shall be #16 or larger.
4. Sensor and signal wiring shall be #18 AWG unless otherwise specifically required by the connected equipment.

### 3.2 EQUIPMENT FOR ELECTRICAL METERING

A. Hawkeye Enercept H8036 Networked (ModbusRTU over RS485) Energy Meter

## 3.3 EQUIPMENT FOR ELECTRICAL MONITORING

A. UtilityVision Panel - Contractor shall purchase from distributor Chevron Monitoring Services. The UtilityVision Panel will contain the following:
   1. One AcquiSuite A8812 metering platform.
   2. One Isobar Ultra4 plug-in strip.
   3. One AcquiSuite A8812 110V ac to 24V DC power transformer.
   4. One 2x4 junction box with dual 110V AC outlets installed. Ready for field connection to 110V AC circuit.
   5. Note: Additional electronic monitoring devices and their associated wiring terminal strips may also be required based on possible custom UtilityVison panel requirements that can arise. Contact Chevron Energy Solutions, Stan Gray (913-748-8667) for additional information as required.

B. Contractor shall terminate all wiring to the appropriate terminal strips per the wiring diagram included in this section.

C. Contractor shall contact Chevron Monitoring Services Manager Stan Gray at 913-748-8667 for equipment purchase information and pricing.

# PART 4 - EXECUTION

## 4.1 EQUIPMENT, CONDUIT, AND WIRING INSTALLATION

A. Furnish and install all labor, materials, equipment, and service necessary to install and commission a complete and operable UtilityVision Monitoring System.

B. Mount UtilityVision Panel in an accessible location in specified utility equipment room, and provide 120Volt Power to the panel. The power source shall be a separate line with its own circuit breaker or circuit protection device, though it can share the same power supply as the BTU meter. Use a three wire service in which one wire is protective earth ground.

C. Install a 1/2" EMT with a CAT 5 cable and RJ45 connectors each end from the UtilityVision Panel to the District's IT network switch. Final connections to the IT switch to be made by the District's Information Technology Department.

D. Furnish and install the electric meter sized as appropriate for the service size to the building. Mount the meter per manufacturer's installation instructions. Install a RS485 network connecting this meter to the UtilityVision Panel. The installation is summarized below.
   1. The Enercept meters are available in amperages of 100, 300, 400, 800, 1600, and 2400, and a voltage range of 208V to 480V. Contractor shall field verify size of conductors and/or busbar to determine required CT size.
   2. Contractor shall set the Modbus address on the meter to 1. If additional meters are installed they shall be numbered 2, 3, 4, etc.
   3. Disconnect power and lock-out all power sources during installation.
   4. Connect the voltage leads to the 3 phase conductors.
   5. Attach CTs to conductors, each attached to the same conductor as the corresponding colored voltage lead.
   6. Install and connect ½" EMT with RS 485 network, utilizing #18 gauge twisted pair, with ground, (Belden 1120A or equivalent) from the Modbus Energy Meter to the UV Panel.

7. Termination schedule shall be as follows:

| Energy Meter | UV Panel |
|---|---|
| RS485 (+) | J20 – RS485 + |
| RS485 (-) | J20 – RS485 - |
| RS48 (Gnd) | J19 – Shield (either Connector) |

Note: RS485 terminal connectors J19 & 20 are found within the UtilityVision A8812 AcquiSuite gateway device, under its outer cover on the right hand side of the main circuit board. Point connection information will be shipped with each panel.

E. All work shall be in conformance with Division 26 00 00.

F. Tag and label. Identify source and circuit numbers in each cabinet, pull and junction box, and outlet box. Color-coding per Division 26 00 00, where applicable.

G. Test-meter installation for proper operation, accuracy, and usability of output data.

H. Coordinate with the Chevron Metering Division to verify that they are able to "view" all installed components from a remote location. Repair or replace malfunctioning metering equipment or correct test setup; then retest. Repeat for each meter in installation until proper operation of entire system is verified.

## 4.2 CLEANING AND PROTECTION

A. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

**END OF SECTION**

# SECTION 26 50 00

# LIGHTING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
1. Luminaires and lampholders.
2. Ballasts.
3. Lamps.
4. Central Lighting Inverter.

### 1.2 SUBMITTALS

A. Submit for:
1. Luminaires: Include electrical ratings, dimensions, mounting, material, required clearances, terminations, wiring and connection diagrams, photometric data, diffusers, and louvers.
2. Ballasts.
3. Lamps.
4. Central Lighting Inverter.

B. Provide the following operating and maintenance instructions from the manufacturer for project closeout, see Project Closeout Requirements in Division 1:
1. Luminaires.
2. Ballasts.
3. Lamps.
4. Central Lighting Inverter.

### 1.3 QUALITY ASSURANCE

A. Regulatory Requirements:
1. Provide luminaires acceptable to code authority for application and location as indicated.
2. Comply with applicable ANSI standards pertaining to lamp materials, lamp ballasts and transformers, and luminaires.
3. Comply with applicable NEMA standards pertaining to lighting equipment.
4. Provide luminaires and lampholders which comply with UL standards and have been listed and labeled for location and use indicated by a testing agency acceptable by the AHJ (e.g. UL, ETL, and the like).
5. Comply with CEC as applicable to installation and construction of luminaires.
6. Comply with fallout and retention requirements of CBC for diffusers, baffles, louvers, and the like.

### 1.4 WARRANTY

A. Ballast Manufacturer's Warranty: Not less than 2 years for magnetic type ballasts and 5 years for electronic type ballasts, based on date of manufacturer embossed on ballast, current with installation date. Warranty includes normal cost of labor for replacement of ballast.

B. Lamp Warranty: 6 months for compact fluorescent, 12 months for fluorescent and HID lamps.

## 1.5 MAINTENANCE

A. Furnish two percent extra lens or louvers for each size and type of fluorescent luminaire.

B. Furnish 10 percent extra lamps for each size and type installed.

C. Furnish 5 percent extra ballasts for each size and type.

## PART 2 - PRODUCTS

## 2.1 LUMINAIRES

A. Luminaires: Refer to description and manufacturers in Luminaire schedule.

B. Where recessed luminaires are installed in cavities intended to be insulated, provide IC rated luminaires or other code approved installation.

C. UL label luminaires installed under canopies, roof or open porches, and similar damp or wet locations, as suitable for damp or wet locations.

D. Recessed Luminaires: Frame compatible with ceiling material installed at particular luminaire location. Provide proper factory trim and frame for luminaire to fit location and ceiling material.

E. Finishes:
1. Manufacturer's standard finish (unless otherwise indicated) over a corrosion resistant primer.
2. Interior Light Reflecting Finishes: White or specular finish with not less than 85 percent reflectances.
3. Exterior Finishes: As detailed in luminaire schedule or on Drawings. Refer cases of uncertain applicability to Architect for resolution prior to release for fabrication.

F. Light Transmitting Components:
1. Plastic diffusers, molded or extruded of 100 percent virgin acrylic.
2. Prismatic acrylic, extruded, flat diffusers, 0.125 inch overall thickness, unless otherwise noted.

G. Fluorescent Luminaires:
1. Provide open lamp fluorescent luminaires without diffusers or guards with turret type, spring loaded sockets.
2. To facilitate multilevel lamp switching, wire lamps within luminaire with outermost lamp at both sides of luminaire on the same ballast, the next inward pair on another ballast and so on to innermost lamp (or pair of lamps).
3. For T5HO lamps, provide twist and lock design sockets, socket body rated to 110C and socket rotor rated to 140C.
4. Provide wire lamp guards on exposed lamp fluorescent luminaires.

## 2.2 BALLASTS

A. General:
1. Provide ballasts UL rated for specified lamps.
2. Thermal Protection: Internal UL Class 'P' with automatic reset.

3. Sound Ratings: Class 'A'. Where not available as standard product from any specified manufacturer, provide quietest rating available.
4. Total Harmonic Distortion: Not to exceed 20 percent of the input current unless otherwise indicated.
5. Input Voltage: Provide universal voltage ballast matching branch circuit supply voltage.
6. Provide quantity of ballasts to provide switching as indicated on Drawings.
7. Provide factory printed wiring diagram on ballast housing.
8. Ballasts used in enclosed and gasketed luminaires shall be of Type 1 construction.
9. Comply with FCC rules and regulations Part 18, Class A concerning generation of both electromagnetic interference and radio frequency interference.
10. Provide three year warranty against defects in materials and workmanship, including either a USD 10 replacement labor allowance or complete replacement including labor by an agent of the manufacturer.

B. Ballasts for Linear Fluorescent Lamps:
1. Power Factor: Minimum 97 percent.
2. Do not provide magnetic fluorescent ballasts.
3. Nondimming Electronic:
   a. Tandem wiring between luminaires may be used to minimize the number of ballasts while accomplishing the switching requirements shown on Drawings. Provide label in lamp compartment of luminaire to identify the function of ballast. Label shall not be visible from room.
   b. Provide ballasts that meet requirements of UL 935, ANSI C82.11 and bear the appropriate UL label.
   c. Provide ballasts that withstand input power line transients as defined in ANSI C62.41, Category-A and IEEE 587.
   d. High frequency operation: Not less than 42kHz.
   e. Lamp Crest Factor: Maximum 1.7 for programmed rapid start ballasts and maximum 1.85 or less for instant start ballasts.
   f. Average Ballast Factor (BF): Minimum 88 percent or as indicated in the luminaire schedule.
   g. Provide 0 degree Fahrenheit minimum starting temperature ballasts for luminaires installed where exposed to anticipated ambient temperature less than 55F.
   h. Manufacturers: Advance, Universal Lighting Technologies, OSRAM/Sylvania, or approved.
4. Dimming Electronic:
   a. Meet requirements of nondimming electronic ballasts.
   b. Do not use tandem wiring between luminaires.
   c. Ballast shall start lamp at any preset light output setting and provide continuous, square law dimming from 100 percent to specified low-end output.

C. Ballasts for Compact Fluorescent Lamps:
1. Power Factor: Minimum 97 percent.
2. Provide ballasts which meet requirements of UL 935, ANSI C82.11 and bear the appropriate UL label.
3. With integral end of lamp life detection and shutdown circuit with automatic reset.
4. Nondimming Electronic:
   a. Series wired, programmed rapid start circuitry.
   b. High frequency operation: Not less than 50kHz.
   c. Lamp Crest Factor: Maximum 1.5.
   d. Average Ballast Factor (BF): Minimum 98 percent.
   e. 0 degree Fahrenheit minimum starting temperature.
   f. Manufacturers: Advance, OSRAM/Sylvania, Universal Lighting

Technologies, or approved.

D. Provide special types as indicated in the luminaire schedule.

## 2.3 LAMPS

A. Provide lamps for luminaires.

B. Provide lamp cataloged for specified luminaire type.

C. Provide similar lamps by a common manufacturer unless indicated in the luminaire schedule.

D. Manufacturers: General Electric, Philips, OSRAM/Sylvania (OSI), Venture, Ushio (MR only), EYE (MR only), or approved unless specific manufacturer is indicated in the luminaire schedule.

E. Incandescent: Not allowed unless noted in luminaire schedule.

F. Fluorescent:
1. Provide 3500K fluorescent lamps unless noted in luminaire schedule.
2. Linear Fluorescent:
   a. T-8: Provide the following:
      1) Bi-pin base, tri-phosphor coated.
      2) CRI equal to or exceeding 85.
      3) 30000 hours rated on three hour switching cycle when used with programmed start ballast.
      4) Compatible with dimming ballasts.
      5) Length and wattage as indicated in the luminaire schedule.
   b. T-5: Provide the following:
      1) bi-pin base, tri-phosphor coated.
      2) CRI equal to or exceeding 85.
      3) Compatible with dimming ballasts.
      4) Length and wattage as indicated in the luminaire schedule.
   c. Do not provide T-12 lamps.
3. Compact Fluorescent:
   a. Single ended, four-pin plug-in base, tri-phosphor coated, CRI exceeding 81, CCT, wattage and configuration as indicated in the luminaire schedule.
   b. Do not provide self ballasted screw-in type unless indicated in the luminaire schedule.
   c. Do not provide magnetic starter type luminaires, ballasts or lamps.

G. Special types as indicated on the luminaire schedule.

## 2.04 CENTRAL LIGHTING INVERTER

A. Furnish and install an Inverter System to provide a reliable source of emergency power, designed to operate during periods of utility line deficiencies without any interruption in power supplied to the connected load. The transfer from utility power to battery power shall utilize a true no break system to prevent sensitive loads from "winking out". The system shall provide a pulse width modulated sine wave output to the connected load, and be capable of powering any combination of electronic, power factor corrected, fluorescent, incandescent or HID lighting. The system shall operate from 0-100% loading, and be rated to deliver full KVA rated output at unity power factor for a minimum of 90 minutes. A boost-tap transformer shall provide regulated output during brownouts within -10% of incoming line voltage without transferring to battery. Upon return to normal AC

utility line power, the system shall recharge the batteries without any interruption of power supplied to the load.

B. Characteristics
1. KVA/KW: 3.7
2. Input Voltage: 277V
3. Output Voltage: 277V

C. Batteries
1. Comply with UL Listing to Standard 924 (Emergency Lighting), Type S batteries shall be designed to provide a minimum 1.5 hours rated output voltage to the connected load in emergency mode without dropping below 87.5% of nominal battery voltage.
2. The batteries shall be enclosed in an enclosure that permits easy maintenance without requiring removal.
3. Sealed Lead Calcium VRLA (Type G): Maintenance Free Construction
4. Minimum 90 minute runtime

D. System Options
1. Provide (8) Normally-on output circuit breakers, monitored, 20amp rating

E. Manufacturer: Dual-Lite Spectron LSN Series Inverter System or approved.

## PART 3 - EXECUTION

### 3.1 COORDINATION

A. Verification of Conditions: Verify ceiling construction, recessing depth and other construction details prior to release of luminaire for shipment. Refer cases of uncertain applicability to Architect for resolution prior to release of luminaires for shipment.

B. Provide lighting indicated on Drawings with a luminaire of the type designated and appropriate for location. Where outlet symbols appear on Drawings without a type designation, provide a luminaire the same as those used in similar or like locations.

C. Provide fluorescent and HID luminaires with ballast compatible to lighting control system as shown in drawings and specifications.

### 3.2 INSTALLATION

A. Install luminaire of types indicated where shown and at indicated heights in accordance with manufacturer's written instructions and with recognized industry practices to ensure that luminaires comply with requirements and serve intended purposes.

B. Align, mount and level luminaires uniformly. Use ball hangers for suspended stem mounted luminaires.

C. Avoid interference with and provide clearance for equipment. Where indicated locations for luminaires conflict with locations for equipment, change locations for luminaire by minimum distance necessary as directed by Architect.

D. Suspended Luminaires: Mounting heights indicate clearances between bottom of luminaire and finished floors.

E. Egress Luminaires: Provide unswitched emergency circuit to exit signs and emergency luminaires from central battery inverter.

F. Interior Luminaire Supports:
1. Support Luminaires: Anchor supports to structural slab or to structural members within a partition, or above a suspended ceiling.
2. Maintain luminaire positions after cleaning and relamping.
3. Support luminaires without causing ceiling or partition to deflect.
4. Provide recessed fluorescent luminaires with four supports as required by DSA.

G. Wiring:
1. Recessed luminaires to be installed using flexible metallic conduit with luminaire conductors to branch circuit conductors in a nearby accessible junction box over ceiling. Junction box fastened to a building structural member within 6 feet of luminaire.
2. Install luminaires for lift out and removal from ceiling pattern without disconnecting conductors or defacing ceiling materials.
3. Flexible connections where permitted to exposed luminaires; neat and straight, without excess slack, attached to support device.
4. Install junction box, flexible conduit and high temperature insulated conductors for through wiring of recessed luminaires.
5. Unit Battery Equipment in Egress Luminaires: Provide unswitched conductor to each egress luminaire from serving circuit. This is for the transfer electronics to determine when power has actually been lost.

H. Relamp luminaires which have failed lamps at completion of work.

## 3.3 ADJUSTING

A. Focus and adjust floodlights, spotlights and other adjustable luminaires, with Architect, at such time of day or night as required.

B. Align luminaires that are not straight and parallel/perpendicular to structure.

## 3.4 CLEANING

A. Clean paint splatters, dirt, dust, fingerprints, and debris from luminaires.

B. Where finish of luminaires and poles has been damaged, touch up finish as directed by manufacturer's instructions.

**END OF SECTION**

# SECTION 26 90 00

# BUILDING LIGHTING ACCEPTANCE TESTING AND DOCUMENTATION

## PART 1 - GENERAL

### 1.1 SCOPE OF WORK

A. This section describes the Acceptance Testing and documentation of the lighting system(s) and outlines the duties and responsibilities of the contracting team for Acceptance Testing.

B. Supply the acceptance requirements to products, equipment and systems provided under this Division, where indicated on plans, and where required by California Title 24 requirements.

C. Engage the services of a firm specializing in commissioning of lighting systems or shall submit contractor qualifications for review by architect where testing and documentation is to be performed by contractor.

### 1.2 THE COMMISSIONING TEAM

A. Form the Commissioning Team of:
1. Electrical contractor's representative.
2. Lighting controls manufacturer's representative.
3. Inspector of record.
4. Owner's staff representative.

## PART 2 - PRODUCTS

### 2.1 DUTIES OF THE TEAM

A. The duties of the Team are as outlined in the Title 24 Requirements and summarized below:
1. Plan, organize and implement the Acceptance Testing process and within 1 month of the award of the contract, submit the names and addresses of the Testing team member(s).
2. The Acceptance testing team shall submit a complete description of the testing procedures and systems to be tested to the architect for review.
3. The Acceptance testing team shall coordinate tests of systems and equipment and assemble documentation related to tests. Submit documentation relative to tests and proposed procedures to design engineer for review prior to submitting documentation to Authority having Jurisdiction (AHJ). Team responsible for performing data analysis, calculation of performance indices and crosschecking of results with the requirements of Title 24 and the Contract documents. The installing contractor or agent responsible for testing and documentation shall record their State of California Contractor's license number or their State of California Professional Registration License number on each Certificate of Acceptance for submittal.
4. Responsible for submitting Certificate of Acceptance including paper and electronic copies of measurements and monitoring results and supporting documentation to the AHJ. Where AHJ questions results or requires additional testing, complete additional testing and provide required documentation at no additional cost to the Owner.

## 2.2 TIME SCHEDULE

A. Determine the time period of the commissioning of the systems by the general contractor and Acceptance testing team. It is important to note that AHJ will not release a final Certificate of Occupancy until a Certificate of Acceptance is submitted that demonstrates that the specified systems and equipment have been shown to be performing in accordance with the Title 24 standards.

## 2.3 ACCEPTANCE TESTING – PHASE I - DOCUMENTATION

A. Team shall assemble documentation showing lighting fixture locations, lighting control device locations, control sequences and notes.

B. Per Title 24 requirements, team shall provide record drawings to building owner within 90 days of receiving a final occupancy permit (refer to other specification sections for requirements on record drawings).

C. Per Title 24 requirements, team shall provide operating and maintenance manuals to the building owner (refer to other specification sections for requirements on operation and maintenance manuals).

## 2.4 ACCEPTANCE TESTING – PHASE II – INSPECTION AND TESTING

A. Team shall review the installation, perform acceptance testing and document results for the following systems:
1. Occupancy Sensors.
2. Manual Daylight Controls.
3. Automatic Daylight Controls.
4. Automatic Time Switch Controls.

B. Review of installation shall confirm lighting fixtures and lighting controls are properly located, identified, calibrated, and set points and schedules programmed per contract document requirements.

## 2.5 ACCEPTANCE TESTING - PHASE III - CERTIFICATION

A. Team shall document operating and maintenance information, complete installation certificate, and indicate test results on the Certificate of Acceptance, and submit the Certificate to the AHJ prior to receiving final occupancy permit. Team shall submit forms LTG-1-A through LTG-3-A as required by Title 24 requirements.

# PART 3 - EXECUTION

## 3.1 ACCEPTANCE TESTS AND DOCUMENTATION

A. Refer to California Title 24, Non-residential manual for specific testing procedures and documentation requirements. The detailed requirements can be found at http://www.energy.ca.gov/title 24/2005standards/index.html. Contractor is responsible for reviewing and complying with these standards

**END OF SECTION**

# SECTION 27 00 00

# TELECOMMUNICATIONS BASIC REQUIREMENTS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. This Section includes general administrative and procedural requirements for Sections under Division 27, and is intended to supplement, not supersede, Division 1 requirements.

B. The requirements described herein include the following:
1. References.
2. Definitions.
3. Submittals.
4. Quality Assurance.
5. Delivery, Storage And Handling.
6. Scheduling.
7. Warranty.
8. Project Management and Coordination Services.
9. Field quality control.
10. Project Closeout and Record Documents.

C. Related Sections
1. Consult other Sections, determine the extent and character of related work, and properly coordinate work specified herein with that specified elsewhere to produce a complete and operable installation.
2. General and Supplementary Conditions and general provisions of Contract apply to 27 00 00 series Sections.
3. Division 0 and Division 1 of the Project Manual apply to 27 00 00 series Sections.
4. Section 27 05 26 - Telecommunications Bonding
5. Section 27 05 28 - Telecommunications Building Pathways
6. Section 27 08 00 - Telecommunications Testing
7. Section 27 11 00 - Telecommunications Rooms
8. Section 27 13 10 - Telecommunications Backbone ISP Cabling
9. Section 27 13 14 - Telecommunications Backbone OSP Twisted Pair Cabling
10. Section 27 13 24 - Telecommunications Backbone OSP Fiber Optic Cabling
11. Section 27 15 13 - Telecommunications Horizontal Cabling

### 1.2 REFERENCES

A. Reference to codes, standards, specifications and recommendations of technical societies, trade organizations and governmental agencies shall mean that latest edition of such publications adopted and published prior to submittal of the bid. Consider such codes or standards a part of this Specification as though fully repeated herein.

B. Codes: Perform Work executed under this Section in accordance with applicable requirements of the latest edition of governing codes, rules and regulations including but not limited to the following minimum standards, whether statutory or not:
1. United States Department Of Labor (DOL) Regulations (Standards - 29 CFR) Part 1910, "Occupational Safety and Health Standards".
2. National Fire Protection Agency (NFPA)
   a. NFPA 70, "National Electrical Code" (NEC).
   b. NFPA 75, "Protection Of Information Technology Equipment."

3. California Code of Regulations (CCR) Title 24, California Building Standards Code Part 2, Basic Building Regulations and Part 3, California Electrical Code (CEC).
4. Uniform Building Code (UBC).
5. Uniform Fire Code (UFC).
6. Uniform Mechanical Code (UMC).
7. National, State, Local and any other binding building and fire codes.
8. FCC Regulations:
   a. Part 15 – Radio Frequency Devices & Radiation Limits.
   b. Part 68 – Connection of Terminal Equipment to the Telephone Network.

C. Standards: Equipment and materials furnished under this Section shall conform to the following standards where applicable:
1. Underwriter's Laboratories (UL): Applicable listing and ratings, including but not limited to the following standards:
   a. UL 444: Communications Cables.
   b. UL 497: Protectors for Paired-Conductor Communication Circuits.
   c. UL 1651: Optical Fiber Cable.
   d. UL 1690: Data-Processing Cable.
   e. UL 1963: Communications-Circuit Accessories.
   f. UL 2024A: Optical Fiber Cable Routing Assemblies.
2. ANSI/TIA/EIA-568-B Commercial Building Telecommunications Cabling Standard.
   a. Part 1: General Requirements.
   b. Part 2: Balanced Twisted-Pair Cabling Components.
   c. Part 2, Addendum 1: Transmission Performance Specifications For 4-Pair 100 Ohm Category 6 Cabling.
   d. Part 3: Optical Fiber Cabling Components Standard.
3. ANSI/TIA/EIA-569-A Commercial Building Standard for Telecommunications Pathways and Spaces, including the following addenda:
   a. TIA/EIA-569-A-1 Surface Raceways.
   b. TIA/EIA-569-A-2 Furniture Pathways and Spaces.
   c. TIA/EIA-569-A-3 Access Floors.
   d. TIA/EIA-569-A-4 Poke-Thru Fittings.
   e. TIA/EIA-569-A-6 Multi-Tenant Pathways and Spaces.
   f. TIA/EIA-569-A-7 Cable Trays and Wirelines.
4. ANSI/TIA/EIA-598-B Optical Fiber Cable Color Coding.
5. ANSI/TIA/EIA-606-A Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.
6. ANSI/J-STD-607-A Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications.
7. ANSI/TIA/EIA-758 Customer-Owner Outside Plant Telecommunications Cabling Standard: TIA/EIA-758-1 Addendum No. 1.
8. EIA testing standards.
9. Insulated Cable Engineers Association (ICEA):
   a. ANSI/ICEA S-80-576-2002 Category 1 & 2 Individually Unshielded Twisted Pair Indoor Cables for Use in Communications Wiring Systems.
   b. ANSI/ICEA S-83-596-1994 Fiber Optic Premises Distribution Cable.
   c. ANSI/ICEA S-87-640-1999 Fiber Optic Outside Plant Communications Cable.
   d. ANSI/ICEA S-90-661-2002 Category 3, 5, & 5e Individually Unshielded Twisted Pair Indoor Cable for Use In General Purpose and LAN Communication Wiring Systems.
   e. ICEA S-104-696-2001 Standard For Indoor-Outdoor Optical Cable.

10. Building Industry Consulting Services International (BICSI):
    a. Telecommunications Distribution Methods Manual (TDMM).
    b. Customer-Owner Outside Plant Design Manual.
    c. Wireless Design Reference Manual (WDRM).
    d. Network Design Reference Manual (NDRM).

D. Make a copy of each document readily available during the course of construction for reference by field personnel.

## 1.3 DEFINITIONS

A. The Definitions of Division 0 shall apply to the 27 00 00 sections.

B. In addition to those Definitions of Division 0, the following list of terms as used in this Section and Sections 27 00 00 shall be defined as follows:
1. "Connect": To install required patch cords, equipment cords, cross-connect wire, etc. to complete an electrical or optical circuit.
2. "Cabling": A combination of cables, wire, cords, and connecting hardware [e.g., cables, conductor terminations, connectors, outlets, patch panels, blocks, and labeling.
3. "Identifier": A unique code assigned to an element of the telecommunications infrastructure that links it to its corresponding record.
4. "Engineer" and "Engineer Of Record": Interface Engineering Inc.

## 1.4 SYSTEM DESCRIPTION

A. In circumstances where the Specifications and Drawings conflict, the most stringent requirement shall apply. Generally, the Drawings shall govern quantity and the Specifications shall govern quality.

**1.5 SUBMITTALS** Submit required submittals in accordance with Section 01 25 00.

B. Obtain approval in writing by the Engineer for the Product Data submittals and for the Shop Drawings (as required) prior to release of order for products and equipment, and prior to installation.

C. Product Data Submittal Requirements
1. Quantity: Submit quantity of product data submittals as described in Section 01 25 00. In the absence of requirements given, submit nine product data submittals.
2. Format:
    a. Product data sheets shall be 8-1/2 x 11 inch pages or 11x17 for oversized information.
    b. Package each submittal with an outer cover. Examples include:
        1) 3-ring binder with front cover and spine having clear pockets for insertion of the submittal information.
        2) 3-hole report cover with transparent front cover. Clearly label each submittal on the outer cover with the following information:
        3) Project name and address.
        4) Submittal Title (e.g., "Product Data Submittal For Telecommunications Equipment Rooms").
        5) Project submittal number.
        6) Specification section number/s (e.g., "Section 27 11 00").
        7) Date and revision; date format: <month> <day>, <year> (e.g., "January 1, 2000").

8) General Contractor / Prime Builder.

9) Telecommunications Installer.

c. Include index dividers for improved navigation through the submittal. Dividers shall match the Table Of Contents.

3. Content:

a. Table Of Contents: Include a Table Of Contents at the beginning of submittal that lists materials by article and paragraph number (e.g., "2.02-A Equipment Racks").

b. Cover Letter: Include a cover letter that states the scope of the submittal and states the submittal is in full compliance with the requirements of the Contract Documents, with a specific reference that the submittal complies with Section 01 25 00 procedures. The cover letter shall be signed (and stamped, if applicable) by the person who prepared the submittal. Failure to comply with this requirement shall constitute grounds for rejection of submittal.

c. Product Information: Product Data submittal shall consist of manufacturer's technical data, product literature, "catalog cuts", data sheets, specifications, and block wiring diagrams (if necessary). Also include applicable Materials Safety Data Sheet (MSDS) for each item complying with OSHA's Hazard Communication Standard 29 CFR 1910.1200. This data shall clearly describe the product's characteristics, physical and dimensional information, electrical performance data, materials used in fabrication, material color & finish, and other relevant information such as test data, typical usage examples, independent test agency information, and storage requirements. Clearly indicate by arrows or brackets precisely what is being submitted on and those optional accessories, which are included and those which are excluded. At a minimum, include products listed in the specifications numbering 27 00 00. Also include relevant products that will be installed, which are not listed in the specifications.

d. Seismic Calculations: Where required, include in the product data submittal the manufacturer's anchorage calculations for floor-mounted, fully loaded equipment racks/frames/cabinets such that it shall remain attached to the mounting surface after experiencing forces in conformance with CCR, Title 24, Table 23P, Part II and with Section 2312 "Earthquake Regulations" of the "Uniform Building Code" for Seismic Zone 4 Area, Importance Factor of 1.25. Specify proof loads for drilled-in anchors, if used. A Structural Engineer currently registered in the State of California shall prepare calculations and shall wet stamp and sign them. Forward calculations to the Owner for review and approval.

e. Resubmittals: Resubmittals shall include a cover letter that lists the action taken and revisions made to each product submittal in response to Submittal Review Comments. Resubmittal packages will not be reviewed unless accompanied by this cover letter. Failure to include this cover letter will constitute rejection of the resubmittal package.

D. Shop Drawings Submittal Requirements

1. Quantity: Submit quantity of shop drawings as described in Section 01 25 00. In the absence of requirements given, submit six sets of shop drawings.

2. Media: Submit shop drawings on media as described in Section 01 25 00. In the absence of requirements given, submit shop drawings full size on bond or eco-bond.

3. Format:

a. Prepare shop drawings using AutoCAD 2000 or later.

b. Full size shall equal the Contract Documents.

c. Use the project title block. Insert company information in title block.

d. Text shall be 3/32" high, minimum, when plotted full size.

e. Device symbols shall match those used in the Contract Drawings.
f. Screen background information.
g. Plot system components (devices, cable routes, etc.) and text at a sufficient line weight to stand out against background information.
h. Label each sheet in the shop drawings set with the Specification Section Number (e.g., "27 13 10").
i. Scaling:
   1) Scale floor plans and reflected ceiling plans at 1/8"=1'-0".
   2) Scale enlarged room plans at 1/4"=1'-0".
   3) Scale wall elevations at 1/2"=1'-0".
   4) Scale rack elevations at 1"=1'-0".

4. Content:
   a. Submit detailed shop drawings if the proposed installation differs from the Contract Documents or the design intent.
   b. Cover Letter: Accompany each shop drawing submittal with a cover letter stating that the shop drawings have been thoroughly reviewed by the Contractor and are in full compliance with the requirements of the Contract Documents. Cover letters shall include a drawing index, and shall be signed (and stamped, if applicable) by the person who prepared the submittal. Failure to comply with this requirement shall constitute grounds for rejection of submittal.
   c. Drawings: Shop drawing submittals shall consist of floor plans, reflected ceiling plans, enlarged room plans, wall and rack elevations, installation details, and any other aspect of the system that differs from the Contract Documents or the design intent. Scales shall be the same as the Drawings (e.g., 1/4" = 1'-0" for enlarged room plans).
   d. Seismic Calculations: As part of the shop drawings submittal, the manufacturer shall provide anchorage calculations for floor mounted fully loaded distribution frames such that it shall remain attached to the mounting surface after experiencing forces in conformance with CCR, Title 24, Table 23P, Part II and with Section 2312 "Earthquake Regulations" of the "Uniform Building Code" for Seismic Zone 4 Area, Importance Factor of 1.25. Specify proof loads for drilled-in anchors, if used. A Structural Engineer registered in the State of California shall prepare Structural Calculations, and shall wet stamp and sign them. Forward calculations to the Owner for review and approval.
   e. Resubmittals: Accompany resubmittals with a cover letter that lists the revisions made to each drawing in response to Submittal Review Comments. Resubmittals will not be reviewed unless accompanied by this cover letter. Failure to include this cover letter will constitute rejection of the resubmittal package.

E. As-Built Drawings Submittal Requirements
1. Quantity: Submit quantity of as-built drawings as described in Section 01 25 00. In the absence of requirements given, submit six sets of as-built drawings.
2. Media: Submit shop drawings on media as described in Section 01 25 00. In the absence of requirements given, submit shop drawings full size on bond or eco-bond.
3. Format:
   a. Prepare as-built drawings using AutoCAD 2000 or later.
   b. Use the same sheet size as the Contract Documents, and use the project title block.
   c. Text: minimum of 3/32" high when plotted at full size.
   d. Use symbols identical to the symbols shown on the Drawings.
   e. Screen background information.
   f. Plot system components (devices, cable routes, etc.) and text at a

sufficient line weight to stand out against background information.

4. Content:
   a. As-Built Drawings shall fully represent actual installed conditions and shall incorporate revisions made during the course of construction.
   b. Floor plans shall show:
5. Locations and identifiers of outlets/devices.
6. Size, quantity, location, and routes of pathways (such as cable basket, conduits, cable hangers, and other cable support devices). Enlarged room floor plans scaled at 1/2"=1'-0" showing exact placement of equipment cabinets/frames, rack bays, and other equipment. Enlarged room overhead plans scaled at 1/2"=1'-0" showing exact placement of overhead cable support devices (e.g., cable basket, cable runway, conduit sleeves, etc.).
7. Applicable rooms: Telecommunications Room
   a. Wall elevations scaled at 1"=1'-0" showing exact placement of termination hardware (e.g., termination/cross-connect blocks).
   b. Installation details.

F. Operation and Maintenance (O & M) Manuals Submittal Requirements
1. Quantity: Submit quantity of O&M Manuals as described in Section 01 25 00. In the absence of requirements given, submit six product data submittals.
2. Format:
   a. Package each O & M Manual in a white, 3-ring binder with front cover and spine having clear pockets for insertion of the project information.
   b. Clearly label the cover of each O & M Manual with the following information:
      1) Client name.
      2) Project name and address.
      3) Manual title (e.g., "Operation And Maintenance Manual for Telecommunications Cabling System").
      4) Date; date format: <month> <day>, <year> (e.g., "January 1, 2000").
      5) Telecommunications Installer and General Contractor names. Include tabbed separators for improved navigation through the manual.
3. Content:
   a. Include a Table Of Contents at the beginning that lists the contents.
   b. 11"x17" prints of As-Built Drawings, as described above.
   c. One CD-ROM of AutoCAD files of as-built drawings.
   d. Manufacturer's original catalog information sheets for each component provided under applicable Section.
   e. Warranty certificate from the manufacturer and the Contractor.
   f. Manufacturer's instructions for system or component use.
   g. Instructions for maintenance and warranty issues.

## 1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications
1. Five continuous years, minimum, design and manufacture of the materials and equipment specified herein.

2. Manufacturer(s) of all products and equipment specified herein shall demonstrate that they have a quality assurance program in place to assure that all of the specifications are met. The program shall include, as a minimum, provisions for:
   a. Incoming inspection of raw materials.
   b. In-process inspection and final inspection of the cable product.
   c. Calibration procedures of all test equipment to be used in the qualifications of the product.
   d. Recall procedures in the event that out of calibration equipment is identified.
3. Conformance to certain government standards on quality assurance may be required for some applications within these specifications.

B. Contractor Qualifications
1. Current, active, and valid C7 or C10 California State Contractors License. Provide a copy of Contractors License in the bid submission.
2. Five, minimum, continuous years experience.
3. Five, minimum, completed projects similar to scope and cost. Provide a list of projects, including references, in the bid submission.
4. Technicians qualified for the work. Provide evidence in the bid submission of Technician qualifications. Evidence shall consist of manufacturer certifications, manufacturer training, industry training, relevant project experience, etc.
5. Also refer to additional requirements stated in Sections 27 05 26 through 27 15 13.

C. Materials
1. Materials and equipment furnished shall be new, unused and without defects.
2. Furnish only specified products and equipment, or products and equipment that have been approved in writing.

D. Regulatory Requirements
1. Work and materials shall conform to the latest rules of National Board of Fire Underwriters wherever such standards have been established and shall conform to the regulations of the State Fire Marshal, OSHA and the codes of the governing local municipalities. Nothing in these specifications is to be construed to permit work not conforming to the most stringent of the applicable codes.
2. Reference to codes, standards, specifications and recommendations of technical societies, trade organizations and governmental agencies shall mean that latest edition of such publications adopted and published prior to submittal of the bid. Consider such codes or standards a part of this Specification as though fully repeated herein.
3. When codes, standards, regulations, etc. allow work of lesser quality or extent than is specified under this series of Sections, nothing in said codes shall be construed or inferred authority for reducing the quality, requirements or extent of the Drawings and Specifications. The Contract Documents address the minimum requirements for construction.

E. Project Management And Coordination Services
1. Provide a project manager for the duration of the project to coordinate this Work with other trades. Coordination services, procedures and documentation responsibility shall include, but shall not be limited to the items listed in this section.
2. Review of Shop Drawings Prepared by Other Subcontractors:
   a. Obtain copies of shop drawings for equipment provided by others that require telecommunication service connections or interface with Division 26 work.

b. Perform a thorough review of the shop drawings to confirm compliance with the service requirements contained in the Division 26 contract documents. Document any discrepancy or deviation as follows:
   1) Prepare memo summarizing the discrepancy.
   2) Provide a copy of the specific shop drawing, indicating via cloud, the discrepancy.
   3) Prepare and maintain a shop drawing review log indicating the following information:
   4) Shop drawing number and brief description of the system/material.
   5) Date of your review.
   6) Indication if follow-up coordination is required.

F. Drawings
1. Layout: Follow the general layout shown on the Drawings except where other work may conflict with the Drawings.
2. Accuracy: Drawings for the Work within this Division are essentially diagrammatic within the constraints of the symbology applied.
3. The Drawings do not fully represent the entire installation for the Telecommunications Cabling System. Drawings indicate the general route for the cables and the location of outlets.
4. Complete the details necessary for point-to-point design. This allows the Contractor to achieve desired results applying their own procedures and methods. Submit shop drawings for review prior to installation.

G. Role of the Engineer
1. During construction, the Engineer will work with the Contractor to provide interpretation and clarification of project contract documents, reply to (and 'process') relevant Requests for Information (RFIs), and act as an interface between the Contractor and the Owner.
2. The Owner has retained the Engineer's services to observe the Work for general compliance with the Contract Documents and to ensure that the installation meets the design intent of the system.
3. In summary, the Engineer will perform the following specific services during the construction phase:
   a. Review product submittals and shop drawings (as required) for general compliance with the contract drawings and specifications.
   b. Review changes as they arise, and confirm that the proposed solutions maintain the intended functionality of the system.
   c. Observe progress of the construction, and report observations back to the Owner.
   d. Review the testing procedures to confirm compliance with project requirements and industry-accepted practices.

## 1.7 DELIVERY, STORAGE AND HANDLING

A. Delivery
1. Products shall not be delivered to the site until protected storage space is available.
2. Coordinate delivery of materials with scheduled installation date to allow minimum storage time at jobsite.
3. Deliver materials in manufacturer's original, unopened, undamaged packaging and containers with identification labels (name of the manufacturer, product name and number, type, grade, UL classification, etc.) intact.
4. Replace equipment damaged during shipping at no cost to the Owner.

B. Storage and Protection
1. Store materials in clean, dry, ventilated space free from temperature and humidity conditions (as recommended by manufacturer) and protected from exposure to harmful weather conditions.
2. Comply with manufacturer's requirements for each product. Comply with recommended procedures, precautions or remedies as described in the Material Safety Data Sheets (MSDS) as applicable.
3. Maintain factory wrapping or provide a heavy canvas/plastic cover to protect units from dirt, water, construction debris, and traffic.
4. Storage outdoors covered by rainproof material is not acceptable.
5. Provide heat where required to prevent condensation or temperature related damage.

C. Handling
1. Handle in accordance with manufacturer's written instructions.
2. Damaged equipment shall not be installed.
3. Replace damaged equipment at no cost to the Owner.
4. Handle with care to prevent internal component damage, breakage, denting, and scoring.

## 1.8 SCHEDULING

A. Unless otherwise specified, the construction schedules of the Sections 27 00 00 may be combined.

B. Submit schedule within 30 days after Notice To Proceed.

## 1.9 WARRANTY

A. Service must be rendered within 4 hours of system failure notification. Note any deviation – exceptions or improvements – to this requirement at the time of bid.

B. Refer to Sections listed in 1.01, C for specific subsystem warranty period requirements.

C. Manufacturers of the major system components shall maintain a replacement parts department and provide testing equipment when needed. A complete parts department or stocking distributor shall be located close enough to the job site area to supply replacement parts within a 4-hour period.

D. Warrant installed hardware, under normal use and service, to be free from defects and faulty workmanship during the warranty period. Keep the system in operating condition at no additional material or labor costs to the Owner during the warranty period.

E. The manufacturers shall demonstrate that a quality assurance program is in place to assure that the specifications are met. The program shall include, as a minimum, provisions for:
1. Incoming inspection of raw materials.
2. In-process inspection and final inspection of the product.
3. Calibration procedures of test equipment to be used in the qualifications of the product.
4. Recall procedures in the event that out of calibration equipment is identified.

F. Conformance to certain government standards on quality assurance may be required for some applications outlined in these specifications.

## PART 2 - PRODUCTS

### 2.1 GENERAL

A. Materials used shall present no environmental or toxicological hazards as defined by current industry standards and shall comply with OSHA and EPA standards, other applicable federal, state, and local laws.

B. Product numbers listed in the 27 00 00 series sections are subject to change by the manufacturer without notification. In the event a product number is invalid or conflicts with the written description, notify the Owner in writing prior to ordering the material and performing any installation work. Provision and installation of the approved changed product will be at no additional cost to the Owner.

### 2.2 SUBSTITUTIONS

A. Requests for substitutions shall conform to the general requirements and procedure outlined in Division 1.

B. Where items are noted as "or equal", a product of equivalent function, design, construction, quality and performance will be considered. Include in the substitution request: catalog cuts, product information, and pertinent test data required to substantiate that the product is in fact equivalent to that specified. Only one substitution will be considered for each product specified.

C. Do not provide substitution material, processes or equipment without written authorization from the Engineer.

D. Substitutions shall be equivalent, in the opinion of the Engineer, to the specified product. The burden of proof of such shall rest with the Contractor. When the Engineer in writing accepts a substitution, it is with the understanding that the Contractor guaranteed the substituted product, component, article, or material to be equivalent to the one specified and dimensioned to fit within the construction. Approved substitutions shall not relieve the Contractor of responsibilities for the proper execution of the work, or from any provisions of the Specifications.

E. Manufacturers' names and model numbers used in conjunction with materials, processes or equipment included in the Contract Documents are used to establish standards of quality, utility and appearance. Materials, processes or equipment that, in the opinion of the Owner, are equivalent in quality, utility and appearance will be approved as substitutions to that specified when "or equivalent" follows the manufacturers' names and model number(s).

F. Whenever any material, process or equipment is specified in accordance with a TIA/EIA specification, an ANSI specification, UL rating or other association standard, present an affidavit from the manufacturer certifying that the product complies with the particular standard specification. When requested by the Engineer, submit supporting test data to substantiate compliance at no additional cost.

G. Pay expenses, without additional charge to the Owner, in connection with substitution materials, processes and equipment, including the effect of substitution on self, subcontractor's or other Contractor's work.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Conditions: Verify conditions, provided under other sections, are acceptable for product installation in accordance with manufacturer's instructions.

B. Pathways: Verify that pathways and supporting devices, provided under other sections, are properly and permanently installed, and that temporary supports, devices, etc., have been removed.

C. Field Measurements: Verify dimensions of pathways, including length of pathways. For example, "true tape" the conduits to verify cabling distances.

### 3.2 FIELD QUALITY CONTROL

A. Staffing: Provide a qualified foreman who is in charge of the Work and who is present at the job site at times Work is being performed. Supervise the work force executing the Work. Perform the installation within the restraints of the construction schedule.

B. Project Management: Coordinate and attend weekly status meetings to review the overall progress and issues to be resolved throughout the course of construction. Prepare and distribute meeting agenda prior to and meeting notes after meetings in a format acceptable to the General Contractor.

C. Scheduling: Prepare an overall construction schedule based on the results of the planning meetings with the General Contractor. Issue schedule to General Contractor for approval. Prepare and issue updated schedules whenever there are modifications.

D. Inspection: Perform inspection after installation. Keep areas of work accessible and notify code authorities, or designated inspectors, of work completion released for inspection. Document completion, and inspection as required.

### 3.3 INSTALLATION

A. Conform to applicable federal, state and local codes, and telephone standards.

B. Coordinate the entire installation with the General Contractor, and their subcontractors, to meet the construction schedule. Include coordination meetings as required to fulfill this requirement.

C. Related Products Installation: Refer to other sections listed in Related Sections paragraph herein for related products installation.

D. Manufacturer's Instructions:
   1. Comply with manufacturer's product data, including product technical bulletins, product catalog installation instructions, and product carton instructions for installation.
   2. Maintain jobsite file and comply with Material Safety Data Sheets (MSDS) for each product delivered to jobsite.

E. Adjusting:
   1. Make changes and revisions to the system to optimize operation for final use.

2. Make changes to the system such that any defects in workmanship are corrected and cables and the associated termination hardware pass the minimum test requirements.

F. Protection:
1. Protect installed products and finish surfaces from damage during delivery and construction.
2. Provide protective coverings on adjacent surfaces for protection from dust.

## 3.4 REPAIR/RESTORATION

A. Replace or repair work completed by others that you deface or destroy. Pay the full cost of this repair/replacement.

B. Paint damaged areas to existing painted surfaces caused by Work.

C. Punch List:
1. Inspect installed work in conjunction with the General Contractor and develop a punch list for items needing correction.
2. Provide punch list to Owner for review prior to performing punch walk with Owner.

D. Re-Installation:
1. Make changes to adjust the system to optimum operation for final use. Make changes to the system such that any defects in workmanship are correct and cables and the associated termination hardware passes the minimum test requirements.
2. Repair defects prior to system acceptance.

## 3.5 CLEANING

A. Clean daily. Remove temporary coverings and protection of adjacent work areas. Remove unused products, debris, spills, or other excess materials. Remove installation equipment.

B. Leave finished work and adjacent surfaces in neat, clean condition with no evidence of damage.

C. Repair or replace damaged installed products.

D. Clean installed products in accordance with manufacturer's instructions prior to Owner's acceptance. Legally dispose of debris.

## 3.6 DEMONSTRATION

A. On completion of the acceptance test, schedule a time convenient with the Owner or Owner's Representative for instruction in the configuration, operation, and maintenance of the system.

B. Provide 4 hours, minimum, of on-site orientation and training by a factory-trained representative. Document dates and times of training, and submit a "sign in" sheet for individuals trained, as part of the close out documentation.

## 3.7 CERTIFICATION

A. Provide to Owner or Owner's Representative a written form of acceptance for signature. Corrections must be completed before Owner or Owner's Representative and Engineer will give acceptance.

**END OF SECTION**

# SECTION 27 05 26

# TELECOMMUNICATIONS BONDING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes: Bonding telecommunications infrastructure devices and equipment to Telecommunications Grounding Backbone.

B. Related Sections
1. Comply with the Related Sections paragraph of Section 27 00 00.
2. Division 26 – Grounding, Telecommunications Grounding Backbone.

### 1.2 REFERENCES

A. Comply with the References requirements of Section 27 00 00.

B. In additional to those codes, standards, etc., list in Section 27 00 00, comply with the latest edition of the following applicable specifications and standards except as otherwise shown or specified:
1. NFPA 70, National Electric Code:
   a. Chapter 8: Communications Systems.
   b. Article 250: Grounding.
2. Underwriters Laboratories, Inc. (UL) UL 467: Grounding and Bonding Equipment.
3. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   a. IEEE 467: IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems.
   b. IEEE P1100:IEEE Recommended Practice for Powering and Grounding Sensitive Electronic Equipment in Industrial and Commercial Power Systems.

### 1.3 DEFINITIONS

A. Definitions as described in Section 27 00 00 shall apply to this section.

B. In addition, the following list of terms as used in this specification shall be defined as follows:
1. "CM": Circular Mil.
2. "MBRGB": Main Building Reference Grounding Busbar.
3. "TBB": Telecommunications Bonding Backbone.
4. "TBC": Telecommunications Bonding Conductor.
5. "TGB": Telecommunication Grounding Busbar.
6. "TMGB": Telecommunication Main Grounding Busbar.

### 1.4 SYSTEM DESCRIPTION

A. Grounding Backbone System – Provided under another section
1. Refer to Division 26 for detailed information regarding the Telecommunications Grounding Backbone system.

2. The Telecommunications Grounding Backbone system contains grounding bus bars, grounding conductors, bonding conductors, and connecting devices (including but not limited to pressure connectors, lugs, clamps, or exothermic welds). These components provide a low impedance path to ground for stray voltages or spurious signals present on telecommunications media and equipment.
3. TMGB: The TMGB is located in the Entrance Facility Room. The TMGB has a connection to the following:
   a. MBRGB.
   b. Overhead cable tray within the room, via TBC.
   c. Ground bushings installed on each entrance conduit within the Entrance Facility, via TBC.
   d. Dedicated power panels within the Entrance Facility serving telecommunication equipment, via TBC.
   e. Each TBB.
4. TBB: TBBs originate in Entrance Facility, and route to the MDF and each IDF with a connection to each TGB.
5. TGB: A TGB exists in the MDF and each of the IDF rooms.

B. Base Bid Work
1. Provide labor, materials and equipment necessary to bond telecommunications infrastructure devices and equipment to Telecommunications Grounding Backbone.
2. TBCs within each telecommunications room from the TMGB and TGBs to the following components:
   a. Rack bay to TMGB/TGB.
   b. Overhead cable support to TMGB/TGB.
   c. Ground bushings installed on each conduit opening within the space if conduit is provided by Contractor to TMGB/TGB.
3. Bonding jumpers between cable basket and cable runway joints and splices, and between overhead cable support and equipment racks.

## 1.5 SUBMITTALS

A. General: Conform to Submittal requirements as described in Section 27 00 00.

B. Quantity: Furnish quantities of each submittal as noted in Section 27 00 00.

C. Product Data Submittal
1. Format: As described in Section 27 00 00.
2. Content: In addition to requirements of Section 27 00 00, include the following:
   a. Product Data: "catalog cuts", data sheets, specifications, and block wiring diagrams (if necessary) of bonding devices and installation accessories. This data shall clearly describe the physical and dimensional information, performance data, electrical characteristics, materials used in fabrication, and material finish.
   b. Clearly indicate by arrows or brackets precisely the model and accessories submitted on.

D. Substitutions: Requests for substitutions shall conform to the general requirements and procedure outlined in Section 27 00 00.

## 1.6 QUALITY ASSURANCE

A. Comply with Quality Assurance requirements of Section 27 00 00.

## 1.7 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Comply with Delivery, Storage and Handling requirements of Section 27 00 00.

## 1.8 WARRANTY

A. Match warranty of Section 27 11 00.

# PART 2 - PRODUCTS

## 2.1 BONDING CONDUCTORS

A. TBC
1. Conductor: #6 AWG (up to 25 feet) stranded copper.
2. Insulation: Low-smoke, green in color. The following shall be printed on the conductor's jacket: insulation grade, conductor gauge, and applicable UL jacket listings.
3. Type THHN, or approved similar.

B. Bonding Straps for Cable Basket, Cable Runway, and/or Cable Tray
1. Conductor: Flexible braided straps with factory terminated connectors.
2. Manufacturer, or equal:
   a. Chatsworth Products Inc #12061-001.
   b. Hoffman #LGK.

## 2.2 CONNECTORS

A. General: Connectors shall be UL listed.

B. TBC-To-TGB/TMGB Connection
1. Lug, one-hole standard barrel compression lug.
2. Manufacturer: Panduit, or equal: #LCD6-14A-L; two hole (1/4" dia. x 5/8" on center) standard barrel lug for #6 AWG conductor.

C. TBC-To-Runway Connection
1. Lug, two-hole single barrel screw termination lug.
2. Manufacturer: Panduit, or equal: #HL4-2-X; one hole (1/4") 'premium' single barrel screw lug for #6 AWG.

D. TBC-To-Equipment Rack Connection
1. Lug, one-hole standard barrel compression lug.
2. Manufacturer: Panduit, or equal: #LCA6-14-L; one hole (1/4") standard barrel compression lug for #6 AWG.

E. TBC "C" Tap
1. C-type copper thick wall compression tap, for making copper-to-copper connection.
2. Manufacturer: Panduit, or equal: #CTAPG4-6-L; C-type compression tap.

## 2.3 MISCELLANEOUS

A. Wire Clamp
1. Material: nylon, UV stabilized.
2. Color: black.

3. Size: 0.25" holding diameter for 6 AWG; or size as required based on conductor size.
4. Manufacturer, or equal: Richco Inc. #N4B-BLK; clamp for 6 AWG.

## PART 3 - EXECUTION

### 3.1 GENERAL

A. Comply with the Execution requirements of Section 27 00 00.

### 3.2 EXAMINATION

A. Examine existing Telecommunications Grounding Backbone system prior to the start of work within this section. The Telecommunications Contractor is solely responsible to ensure work proposed within this section is fully compatible, in the opinion of the Engineer, with the existing Telecommunications Grounding Backbone system.

### 3.3 INSTALLATION

A. Provide TBC and appropriate grounding hardware from telecommunication conduit, cable tray, cable runway, equipment racks, and other metallic telecommunication infrastructure components to the nearest TMGB/TGB as shown on Drawings.

B. Telecommunication Bonding Conductors
1. Refer to Drawings for TBC sizing. If not shown, size TBCs as the greater of six AWG or based on length of run using 1000CM/linear foot.
2. Install TBCs in a manner that will protect them from physical and mechanical damage.
3. Routing:
   a. Route TBCs in the shortest possible path, using right-angles for turns and routed parallel to building lines.
   b. Utilize a minimum 1-foot bend radius.
4. At TMGB/TGBs:
   a. Thoroughly clean non electrotin-plated busbar prior to fastening the conductors, bolts, or connectors to the busbar.
   b. Attach lugs to busbar with appropriate size cadmium bronze bolt, flat washer and Belleville washer.
   c. Torque connections.

C. Rack Bay & Overhead Cable Support Bonding
1. Refer to Drawings for detailed diagrammatic requirements for rack bay bonding.
2. Rack Bay: Bond equipment racks, frames, frame bays, cabinets, server racks, and other similar support systems located within the same room or space as the TMGB/TGB to the busbar.
3. Overhead Cable Support:
   a. Bond overhead runway located within the same room or space as the TMGB/TGB to the busbar.
   b. Provide "grounding kit" (straps & connectors) to bond sections of cable runway for ground continuity. This requirement shall apply to sections of cable runway within a single communication room.

## 3.4 LABELING

A. General Requirements
   1. Labeling, identifier assignment, and label colors shall conform to TIA/EIA-606-A Administration Standard and as approved by Owner's Representative before installation.
   2. Permanently label TBCs. Affix label as close as practical to each end of the conductor.

B. Label Format
   1. Labels shall be permanent with machine-generated text; hand written labels will not be accepted.
   2. Labels on TBCs shall fully wrap around conductors with a self-laminating feature to provide permanent marking.

C. Identifier Assignment
   1. Separate label fields of the identifier with a hyphen.
   2. TBC:
      a. First field: "TBC" (the bonding conductor type).
      b. Second field: The room identity where TBC exists; for example: "B01-TDA".
      c. Third field: A unique sequential number; for example: "01", "02", etc.
      d. Example: "TBC–B01-TDA–01."

## 3.5 RECORDS

A. Communication Bonding System records shall conform to TIA/EIA-606-A Administration Standards. Each component shall have as a minimum, the information as outlined in Table 4.7-1 of TIA/EIA-606-A.

**END OF SECTION**

# SECTION 27 05 28

# TELECOMMUNICATIONS BUILDING PATHWAYS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes: Telecommunications building pathways.

B. Related Sections
1. Comply with the Related Sections paragraph of Section 27 05 28.
2. Section 27 15 13 – Telecommunications Horizontal Cabling.
3. Section 27 13 10 – Telecommunications Backbone ISP Cabling.
4. Section 27 13 14 – Telecommunications Backbone OSP Twisted Pair Cabling.
5. Section 27 13 24 – Telecommunications Backbone OSP Fiber Optic Cabling.
6. Division 26 – Basic Materials and Methods, Conduit, Cable Tray, Boxes.

### 1.2 REFERENCES

A. Comply with the References requirements of Section 27 00 00.

B. In additional to those codes, standards, etc., list in Section 27 00 00, comply with the latest edition of the following applicable specifications and standards except as otherwise shown or specified:
1. ASTM A 510 Specifications for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel.
2. ASTM B 633 Specifications for Electrodepositing Coatings of Zinc on Iron and Steel, Sections SC2 and SC3.
3. ASTM A 653 Specifications for Steel Sheet, Zinc-Coated (Galvanized) by Hot Dip Process.
4. ASTM A 591 Specifications for Electrodepositing Coatings of Zinc on steel wire or sheets.
5. ASTM A 123 Specifications for Zinc (Hot Galvanized) Coatings on Iron and Steel.

### 1.3 DEFINITIONS

A. Definitions as described in Section 27 00 00 shall apply to this section.

B. "Cable Hanger": A metal, most often steel, cable support device shaped (section view) similar to the letter J; alternately, a fabric strap. The device is available in different sizes supporting different quantities of cables, and is also available with different attachment hardware to be supported by different methods (e.g., wire support, beam flange clip, etc.).

C. "J-Hook": Another name for cable hangers.

### 1.4 SYSTEM DESCRIPTION

A. Work Covered Under Other Sections: Conduit, pull boxes, device boxes.

B. Base Bid Work
   1. The work under this section shall include the planning and coordination with General Contractor (and other trades) of telecommunications system building pathways, the furnishing of necessary materials, and the labor & associated services required to install pathways.
   2. The Telecommunications Building Pathways consist of the following subsystems:
      a. ISP innerduct, from MDF to IDFs, as shown on Drawings.
      b. Primary Pathways: Cable Basket, Cable Tray, Liner Ring Pathway, including supports.
      c. Secondary Pathways: Cable Hangers, including supports.
      d. Surface Raceway.

## 1.5 SUBMITTALS

A. General: Conform to Submittal requirements as described in Section 27 00 00.

B. Quantity: Furnish quantities of each submittal as noted in Section 27 00 00.

C. Submittal Requirements at Start Of Construction:
   1. Product Data Submittal.
   2. Shop Drawings Submittal: Consisting of proposed changes to pathway route plans.

D. Submittal Requirements at Close Out: As-Built Drawings Submittal (can be combined with shop drawings of Section 27 15 13).

E. Substitutions: Requests for substitutions shall conform to the requirements and procedure in Section 27 00 00.

## 1.6 QUALITY ASSURANCE

A. Comply with Quality Assurance requirements of Section 27 00 00.

B. NFPA Compliance: Comply with NFPA 70B, "Recommended Practice for Electrical Equipment Maintenance" pertaining to cable tray series of specifications.

## 1.7 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Comply with Delivery, Storage and Handling requirements of Section 27 00 00.

## 1.8 WARRANTY

A. Comply with Warranty requirements of Section 27 00 00.

# PART 2 - PRODUCTS

## 2.1 INSIDE PLANT INNERDUCT, RISER RATED

A. Application: Suitable for an indoor installation, typically within a riser system or backbone conduit, for the support of telecommunications fiber optic cables.

B. Description: Designed and manufactured as a continuously extruded corrugated pipe.

C. Material: Fabricated from Capron resin, or equivalent.

D. Manufacturers, or equal:
1. Carlon "Riser Guard" series innerduct.
2. Endot "Endocor/RI" series innerduct.
3. Pyramid "Fire Flex Riser Duct" series innerduct.

## 2.2 INSIDE PLANT INNERDUCT, PLENUM RATED

A. Application: Suitable for an indoor installation, typically within a riser system or backbone conduit, and within plenum spaces, such as above ceiling or within an access floor, for the support of telecommunications fiber optic cables.

B. Description: Designed and manufactured as a continuously extruded corrugated pipe.

C. Material: Fabricated from PVDF resin, or equivalent.

D. Manufacturers, or equal:
1. Carlon "Plenum Guard" series innerduct.
2. Endot "Endocor/PL" series innerduct.
3. Pyramid "Fire Flex Plenum Duct" series innerduct.

## 2.3 CABLE BASKET

A. Application: Suitable for indoor installation to support, store, and manage telecommunications cables, either overhead or mounted vertically on a wall.

B. Description: Cable basket shall be made of high strength steel wires and formed into a mesh pattern with intersecting wires welded together. Wire ends along sides (flanges) shall be rounded during manufacturing for safety of cables and installers. Straight section longitudinal wires shall be straight with no bends.

C. Materials and Finishes: Material and finish specifications for each wire basket type pathway are as follows:
1. Yellow Zinc Dichromate: Straight sections shall be made from steel meeting the minimum mechanical properties of ASTM A510 and shall be electro-plated yellow zinc dichromate in accordance with ASTM B633 SC2.
2. Paint: Straight sections shall be painted flat black over Yellow Zinc Dichromate.
3. Hardware shall be either yellow zinc dichromate in accordance with ASTM B633 SC2 or AISI Type 304 Stainless Steel.

D. Refer to Drawings for sizes.

E. Manufacturers, or equal:
1. B-Line WB series.
2. Cablofil EZ-Tray series.
3. GS Metals Flextray series.
4. Chalfant Wire Mesh series.

## 2.4 CABLE HANGERS

A. Application: Suitable for indoor installation within ceiling space for the support of telecommunications cables.

B. Listings: UL 2043, for use in air handling spaces.

C. Manufacturers (or variation per installation method), or equal:
1. B-Line #BCH12-W2; hanger for up to 16 cables.
2. B-Line #BCH21-W2; hanger for up to 50 cables.

3. B-Line #BCH32-W2; hanger for up to 80 cables.
4. Erico #CAT12; hanger for up to 16 cables.
5. Erico #CAT2; hanger for up to 50 cables.
6. Erico #CAT32; hanger for up to 80 cables.
7. Panduit #JMJH2-X20; hanger for up to 30 cables.
8. Panduit #JMJH2W-X20; hanger for up to 30 cables, wall-mount type.

## 2.5 DROP WIRE

A. Application: Suitable for indoor installation within ceiling space into structure above (e.g., slab and/or deck) for the support of telecommunications support devices.

B. Listings: UL 2043, for use in air handling spaces.

C. Assembly shall be equipped with ceiling clip, pre-mounted fastening pin, plastic washer, and pre-tied wire.
1. Fastening pin shall be 7/8".
2. Wire shall be 12 gauge.

D. Manufacturer, or equal: Hilti #CC27 X-AL-H22P8T xx ft PT; drop wire assembly, xx foot wire – where "xx" is the length.

## 2.6 LINEAR RING SYSTEM ("SNAKE TRAY SERIES 201")

A. Application: Suitable for indoor installation within ceiling space for the support of telecommunications cables.

B. Description: Designed and manufactured as sections from a single wire spine and multiple support rings. The sections shall be hand-bendable in any direction along any plane, and shall not require tools, cutting, clipping or modifications to the structure of the tray to create the bend. The system shall allow cables to enter or exit in any direction at any point along the length of the sections, while also providing for the addition or removal of cables without modification or manipulation of the system, including hanging hardware.

C. Material: Wire, both spine and rings, shall be cold rolled steel in accordance with ASTM A510 and zinc plated in accordance with ASTM B633 SC2.

D. Finish: Yellow Zinc Dichromate plated in accordance with ASTM A633 type II SC2.

E. Accessories
1. Accessories include, but are not limited to, threaded rod, coupling adapters, tray connectors, mounting brackets, turnout components and other necessary installation accessories.
2. Accessories shall be made from high strength steel wires and/or sheet steel formed, welded and plated as required as per applicable ASTM standards.

F. Manufacturer: Cable Management Solutions
1. #CM-201-3-8; Snake Tray Series 201, 3"D x 3"W ring size.
2. #CM-201-425-8; Snake Tray Series 201, 4.25"D x 4.25"W ring size.
3. #CM-201-6-8; Snake Tray Series 201, 4"D x 6"W ring size.
4. #CM-201-425D-8; Snake Tray Series 201, 4.25"D x 4.25"W two sets of rings.
5. #CB-10; tray connector.
6. #WBN-201; wall mount bracket.
7. #CBN-201; cabinet-top mount bracket.
8. #TO-101; cable drop out.

## PART 3 - EXECUTION

### 3.1 GENERAL

A. Comply with the Execution requirements of Section 27 00 00.

### 3.2 EXAMINATION

A. Examine areas to receive overhead hanger/support system prior to the start of work within this section. Notify the General Contractor of conditions that would adversely affect the installation or subsequent utilization of the system. Do not proceed with installation until unsatisfactory conditions are corrected.

B. Installer is responsible for the integrity of the structures to which the system is attached, including their capability of safely accepting the loads imposed as evaluated by a qualified engineer

### 3.3 INSTALLATION

A. Innerduct
1. Provide innerduct for routing of fiber optic cables. The innerduct shall be continuous from originating room to destination room. Truncate the innerduct in either room prior to slack storage.
2. When routing through corridors, place innerduct in the cable tray / primary pathway/dedicated supports. When routing vertically through telecommunications rooms, support innerduct on vertical cable support (such as runway) and fasten using cable ties. When routing horizontally through telecommunications rooms, support innerduct on overhead cable support and fasten using cable ties. Install cable ties at 24-inch intervals.
3. Label innerducts at both ends. The label shall be visible to a technician standing at-ease.

B. Cable Basket
1. Install cable basket pathway system in accordance with manufacturer's instructions and recognized industry practices, and ensure that the installed system complies with requirements of the NEC, and applicable portions of NFPA 70B and NECA's "Standards of Installation" pertaining to general electrical installation practices.
2. Install system at locations indicated on the drawings. Routes are diagrammatic in nature. Field verify route prior to installation.
3. Provide center-support hangers, trapeze hangers, or wall brackets to support/hang the cable basket pathway. If not shown in the Drawings, provide 3/8-inch diameter threaded rods for the trapeze hangers and/or center-support hangers. For wall brackets, use approved fasteners depending on the mounting substrate. Support separation shall conform to applicable codes.
4. Splice straight sections using hardware specifically designed for the purpose with serrated flange locknuts.

C. Cable Hangers

1. Install hangers in accordance with recognized industry practices, to ensure that the installed system complies with requirements of the NEC, and applicable portions of NFPA 70B and NECA's "Standards of Installation" pertaining to general electrical installation practices.
2. Provide dedicated supports at sixty inches (60") separation, maximum, per a given route. Supports shall consist of #12 wire or ¼" threaded rod. Suspend wire or rod using components appropriate for the structure – e.g., powder-actuated clip fastener for wire, beam flange clip or angled flange clip for either wire or rod, or an embedded anchor for the threaded rod. Do not share support (wire/rod) with other trades. Do not support the hanger on ceiling grid support wires. Do not support the hanger from ductwork, piping, or other equipment hangers.
3. Install hangers six inches (6"), minimum, from light fixtures or other EMI source. Install hangers between six inches (6") and twelve inches (12") above ceiling grid.

D. Linear Ring Pathway System

1. Install linear ring pathway system in accordance with manufacturer's instructions and recognized industry practices, and ensure that the installed system complies with requirements of the NEC, and applicable portions of NFPA 70B and NECA's "Standards of Installation" pertaining to general electrical installation practices.
2. Install system at locations indicated on the drawings. Routes are diagrammatic in nature. Field verify route prior to installation.
3. Provide dedicated supports for system at a maximum forty-eight inch (48") on center, per a given route. Supports shall consist of 3/8" (maximum size) threaded rod with appropriate hardware (nuts, washers, etc.). Do not share threaded rod with other trades.
4. Install system a minimum of six inches (6") from light fixtures, or other EMI sources. Install system between six inches (6") and twelve inches (12") above ceiling grid.
5. Provide materials necessary to properly support system from existing building construction per manufacturer's instructions, and meeting or exceeding recognized industry practices, and as appropriate for this project. Do not support from ductwork, piping, or other equipment hangers.
6. Splice system sections using UL classified connector bolt, supplied by the same manufacturer.
7. Ground system per NEC 70 Article 250. Provide approved connection bolt to join system sections such that the spine of the system is considered a bonding jumper. Properly bond system to approved ground, as per NEC Article 250. Provide external grounding strap at expansion joints, sleeves, crossovers, and at other locations where system continuity is interrupted.

**END OF SECTION**

**SECTION 27 08 00**

**TELECOMMUNICATION TESTING**

## PART 1 - GENERAL

### 1.1 SCOPE OF WORK

A. Section Includes: Testing of Telecommunications Backbone and Horizontal Cabling subsystems.

B. Related Sections
1. Consult all other Sections and Divisions, determine the extent and character of related work and properly coordinate work specified herein with that specified elsewhere to completely test a complete and operable system.
2. Section 27 00 00 – Basic Telecommunications Requirements.
3. Section 27 15 13 - Telecommunications Horizontal Cabling.
4. Section 27 13 10 – Telecommunications Backbone ISP Cabling.
5. Section 27 13 14 – Telecommunications Backbone OSP Twisted Pair Cabling.
6. Section 27 13 24 – Telecommunications Backbone OSP Fiber Optic Cabling.

C. Products Furnished and Installed Under Other Sections: Telecommunications Cabling.

### 1.2 REFERENCES

A. Comply with Section 27 00 00 References requirements.

B. Additional references to those listed in Section 27 00 00.
1. TIA/EIA-526-14 ("OFSTP-14") Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant.
2. TIA/EIA-526-7 ("OFSTP-7") Measurement of Optical Power Loss of Installed Singlemode Fiber Cable Plant.
3. TIA/EIA-455-171 Attenuation By Substitution Measurement – For Short-Length Multimode Graded-Index And Single-Mode Optical Fiber Cable Assemblies (a.k.a., FOTP-171).

### 1.3 DEFINITIONS

A. Refer to Definitions of Sections 27 00 00, 27 15 13, 27 13 10, 27 13 14, and 27 13 24.

B. In addition, the following list of terms as used in this specification shall be defined as follows:
1. "Adapter" (associated with fiber connectivity): Shall mean a connecting device joining 2 fiber connectors, either like or unlike.
2. "Channel": Shall mean a testing configuration which includes the Permanent Link and the line cord (at the workstation), the equipment cord, and, if a full crossconnection is implemented, a patch cord and the crossconnect termination/connecting apparatus.
3. "Connect": Shall mean install all required patch cords, equipment cords, cross-connect wire, etc. to complete an electrical or optical circuit.
4. "Cord": Shall mean a length of cordage having connectors at each end. The term "Cord" shall be synonymous with the term "Jumper". The cord may be:
   a. Unshielded twisted pair.
   b. Fiber (multimode or singlemode), jacketed & buffered.

5. "Launch Cord": Shall mean the cord certified for use in fiber optic characterization testing, as described in this section.
6. "OTDR": Shall mean Optical Time Domain Reflectometer.
7. "Passive Link Segment": Shall mean the cable, connectors, couplings, and splices between two fiber optic termination units.
8. "Permanent Link": Shall mean the 'permanent' portion of the Horizontal cabling to each outlet with the test cords de-embedded from the measurements; this includes cable, consolidation point (if used), termination/connecting apparatus in the IDF and the connector at the outlet.
9. "System Cord": Shall mean the cord used in the operating electrical or optical circuit.
10. "Test Cord": Shall mean the cord certified for use in testing, as described in this section.

## 1.4 SYSTEM DESCRIPTION

A. Work Provided Under Other Sections
1. Refer to Section 27 15 13 for a more complete System Description.
2. Backbone Cabling: The Backbone Cabling includes twisted pair and fiber cabling.
3. Horizontal Cabling: The Horizontal Cabling, in general, consists of multiple 4-pair Category 6 UTP cables to each outlet. Refer to the Drawings for specific requirements.

B. Base Bid Work
1. Testing of a completed Telecommunications Cabling System, including:
   a. Procedures Submittals.
   b. Equipment Submittals.
2. Testing Requirements:
   a. Fiber optic passive link segment(s):

**Table 270800-1.1:** Tests For Fiber Optic Passive Link Segments

| Subsystem | Type | Test | Direction | Wavelength |
|---|---|---|---|---|
| Backbone | Multimode | Characterization | Both | 850nm and 1300nm |
| Backbone | Singlemode | Characterization | Both | 1310nm and 1550nm |
| Backbone | Multimode | Passive Link Ins. Loss | One | 850nm and 1300nm |
| Backbone | Singlemode | Passive Link Ins. Loss | One | 1310nm and 1550nm |

   b. Multipair/UTP cabling:

**Table 270800-1.2:** Tests For Multipair/UTP Cabling

| Subsystem | Type | Test | Configuration | Notes |
|---|---|---|---|---|
| Backbone | Riser | Wire map & length | - | - |
| Horizontal | CAT6 | Category 6 | Permanent Link | Per TIA/EIA-568-B.2-1 |

   c. Record Documents, including test reports.

## 1.5 SUBMITTALS

A. Refer to Submittals of to Section 27 00 00 for procedural, quantity, and format requirements.

B. Preconstruction Submittal Requirements:
1. Testing Procedures Submittal, describing step-by-step procedures used by the field technicians.

2. Product Submittal, including cut sheets of testing equipment to be used (note all software/firmware versions as applicable) and certificate of last calibration.
3. Schedule Submittal, consisting of proposed schedule of work. This schedule may be combined with the schedule developed for 27 00 00 series Sections.

C. Submittal Requirements at Closeout: Record Documents.

D. Submittal Description: Record Documents
1. Test Reports: Record documents submittal shall include test reports showing the following information:
   a. A title page which includes:
      1) Client Name.
      2) Project Name.
      3) Project Address.
      4) General Contractor name / Telecommunications Installer name.
      5) Date of Submittal.
   b. Individual tabs which break down the test results by building, and then by telecommunications room.
   c. All Backbone Fiber Optic "Post Installation" Passive Link Attenuation test results (utilize the forms provided in Part 4 of this specification for documentation of test results if the tester used does not have data storage capabilities) and Fiber Optic OTDR test results.
   d. All Backbone UTP test results.
   e. All Horizontal cable test results, per cable.
2. Furnish all test results on CD-ROM in their native data format and an exported Microsoft Excel compatible format.
   a. Include all necessary software to allow viewing and printing of individual test results.
   b. CD shall be labeled with the project name, contractor name, and date of submission.

## 1.6 QUALITY ASSURANCE

A. Comply with the Quality Assurance requirements of Section 27 00 00.

## 1.7 WARRANTY

A. Warrant the validity of the test results. Under no circumstances shall any cable's test results be substituted for another's. If a single instance of falsification is confirmed, the Contractor shall be liable for a complete retest of the cabling system at no additional cost to the Owner. This includes the retaining the services of a neutral party to observe all retesting.

# PART 2 - PRODUCTS

## 2.1 GENERAL

A. The manufacturer may change the product numbers listed in this Section at any time, as well as software and firmware versions. In the event this Section contains an invalid product number or conflicts with the written description, or specifies an out-of-date software and/or firmware version, notify the Engineer in writing prior to issuing submittals or field testing.

## 2.2 FIBER OPTIC LIGHT SOURCE

A. All connection interfaces shall be factory installed. No field-configurable adapters will be allowed at the light source.

B. Wavelengths output shall be continuous.

C. LED-based light source for multimode fiber testing shall have a:
1. Center wavelength of 850nm ± 30nm and 1300n ± 20nm.
2. Spectral width (FWHM) 30nm - 60nm at 850nm and 100nm - 140nm at 1300nm.
3. Minimum output power level of ≥14dBm.

D. VCSEL-based light source for multimode fiber testing shall have a:
1. Center wavelength of 850nm ± 30nm and 1300n ± 20nm.
2. Spectral width (FWHM) 30nm - 60nm at 850nm and 100nm - 140nm at 1300nm.
3. Minimum output power level of ≥14dBm.

E. LASER-based light source for singlemode fiber testing shall have a:
1. Center wavelength of 1310n ± 20nm and 1550n ± 20nm.
2. Spectral width (FWHM) of ≤5nm at 1310nm and ≤5nm at 1550nm.
3. Minimum output power level of ≥3dBm.

F. The light sources may contain internal lenses, pigtails, and modal conditioners, provided they meet the launch conditions as described in "Post-Installation" Passive Link Attenuation Testing Procedures (ref. PART 3 - EXECUTION).

G. Equipment shall be factory-calibrated within 12 months of testing date.

H. Equipment:
1. Agilent Technologies' WireScope 350 test set.
   a. #450-1070 Fiber SmartProbe testing adapter, multimode 850nm.
   b. #450-1080 Fiber SmartProbe testing adapter, multimode 1300nm.
   c. #450-2020 Fiber SmartProbe testing adapter, singlemode 1300nm.
   d. ScopeData management software (version 5.20 or higher).
2. Corning Cable Systems
   a. #OS-301 light source.
   b. #OS-302 light source.
   c. #OS-100D light source.
3. Fluke Networks' DSP-4300 test set
   a. #DSP-4300; "CableAnalyzer" test kit, loaded with firmware version 3.0.4.
   b. #DSP-FTA420S; 'Multimode' fiber testing adapter, LED-based (850nm, 1300nm).
   c. #DSP-FTA430S; 'Singlemode' fiber testing adapter, LASER-based (1310nm, 1550nm).
   d. #DSP-FTA440S; 'Gigabit' fiber testing adapter, VCSEL-based (multimode @ 850nm and singlemode @ 1310nm).
   e. LinkWare; "LinkWare" management software (latest version).
4. Laser Precision #5150 test set.

## 2.3 FIBER OPTIC POWER METER

A. The power meter for both multimode and singlemode testing must be capable of measuring relative or absolute power, and must be independent of modal distributions.

B. All power meters used must be calibrated and traceable to the National Bureau of Standards.

C. All power meters used shall have the following performance:
   1. Dynamic range of 0dBm to -40dBm, minimum.
   2. Accuracy of ±0.2dB.

D. Equipment shall be factory-calibrated within 12 months of testing date.

E. Equipment:
   1. Agilent Technologies' WireScope 350 test set
      a. #450-1070 Fiber SmartProbe testing adapter, multimode 850nm.
      b. #450-1080 Fiber SmartProbe testing adapter, multimode 1300nm.
      c. #450-2020 Fiber SmartProbe testing adapter, singlemode 1310nm.
      d. ScopeData management software (version 5.20).
   2. Corning Cable Systems
      a. #OTS-210 power meter, with data storage capacity.
      b. #OTS-310 power meter, with data storage capacity.
   3. Laser Precision #5025 test set.

## 2.4 FIBER OPTIC MANDREL

A. For jacketed (3.0 mm) fiber, mandrel diameter shall be 22 mm for 50/125 um fiber. For unjacketed buffered (0.9 mm) fiber, mandrel diameter shall be 25 mm for 50/125 um fiber.

B. Equipment: Fluke Networks: #NF-MANDREL-50; red mandrel for jacketed 50/125 um fiber.

## 2.5 FIBER OPTIC OTDR

A. Multimode Source Module:

| Wavelength | Dynamic Range | Attenuation Deadzone | Reflective Deadzone | Loss Resolution | Distance Accuracy |
|---|---|---|---|---|---|
| 850nm | 24dB | 6.5mt | 3.0mt | 0.001dB | 0.1mt |
| 1300nm | 27dB | 7.0mt | 3.0mt | 0.001dB | 0.1mt |

B. Singlemode Source Module:

| Wavelength | Dynamic Range | Attenuation Deadzone | Reflective Deadzone | Loss Resolution | Distance Accuracy |
|---|---|---|---|---|---|
| 1310nm | 40dB | 6.0mt | 3.5mt | 0.001dB | 0.1mt |
| 1550nm | 28dB | 12.0mt | 3.5mt | 0.001dB | 0.1mt |

C. Equipment, including main unit and source modules, shall be factory-calibrated within 12 months of testing date.

D. Equipment:
   1. Agilent Technologies #8147, for multimode & singlemode systems
   2. Corning Cable Systems,
      a. 2001HR, for multimode & singlemode systems.
      b. 340 OTDR Plus Multitester II.
      c. MiniOTDR+, for multimode & singlemode systems.
   3. Tektronix,
      a. TFP2A FiberMaster.
      b. TFS3031 TekRanger2.

## 2.6 FIBER OPTIC TEST CORDS

A. Multimode Fiber Optic Test Cord
   1. The fiber of the multimode test cord(s) shall have the core diameter and numerical aperture nominally equal to that of the multimode fiber optic passive link.
   2. The length of test cords used for insertion loss testing shall be between 1m and 5m.
   3. The connectors of the test cords shall be compatible with the connector types of the light source and the power meter: The connector of the test cords shall be that which the light source accepts.
   4. The connectors shall exhibit <= 0.5dB loss per connection @ both 850nm and 1300nm, as measured per FOTP-171 D2.

B. Singlemode Fiber Optic Test Cord
   1. The fiber of the singlemode test cord(s) shall have the mode field diameter nominally equal to that of the singlemode fiber optic passive link.
   2. The length of test cords used for insertion loss testing shall be between 1m and 5m.
   3. The connectors of the test cords shall be compatible with the connector types of the light source and the power meter: The connector of the test cords shall be that which the light source accepts.
   4. The connectors shall exhibit <= 0.5dB loss per connection @ both 1300nm and 1550nm, as measured per FOTP-171 D3.
   5. All singlemode connectors shall inhibit Fresnel reflections (i.e., have a "PC" finish).

## 2.7 CATEGORY 6 HORIZONTAL CABLE TESTER

A. Equipment shall meet TIA/EIA-568B.2 Addendum 1 requirements for Level III accuracy.

B. Test Standards (minimum): TIA Category 6 (per TIA/EIA-568B.2 Addendum 1); ISO/IEC 11801 Class C and D; ISO/IEC 11801-2000 Class C and D, 1000Base-T, 100Base-TX; IEEE 802.3 10Base-T; ANSI TP-PMD; IEEE 802.5

C. Areas of Test Measurement (minimum): Wire Map; Length; Insertion Loss; Near End Crosstalk (NEXT) loss, at both master unit and remote unit; Power Sum NEXT (PSNEXT) loss, at both master unit and remote unit; Equal Level Far End Crosstalk (ELFEXT), at both master unit and remote unit; Power Sum ELFEXT, at both master unit and remote unit; Return Loss (RL), at both master unit and remote unit; Propagation Delay and Delay Skew; Attenuation-to-Crosstalk Ratio (ACR), at both master unit and remote unit; Power Sum ACR (PSACR), at both master unit and remote unit; Characteristic Impedance; DC Loop Resistance.

D. Equipment: Agilent Technologies
   1. #N2600A-100; "WireScope 350" test kit (main unit, remote unit, CAT6 permanent link probe, CAT6 channel probe, accessories), loaded with firmware version 3.1.1.
   2. "ScopeData Pro" reporting and documentation software latest version.

E. Equipment: Fluke Networks
   1. #DTX-1200 or #DTX-1800; "DTX CableAnalyzer" test kit (main unit, remote unit, CAT6 permanent link adapters, CAT6 channel adapters, accessories), loaded with latest version of firmware.

2. #DSP-4300; "CableAnalyzer" test kit (main unit, remote unit, CAT6 permanent link adapters, CAT6 channel adapters, accessories), loaded with firmware version 3.0.4.
3. "LinkWare" reporting and documentation software (version 1.1, or higher).

## 2.8 BACKBONE UTP CABLING TESTERS

A. Wire Map (continuity, opens, shorts, crossed pairs, split pairs) tester, or equal: Siemon #MT-5000 test unit, with 25-pair adapter.

B. Length tester, or equal: Harris #TS-90 test unit.

# PART 3 - EXECUTION

## 3.1 SCHEDULING

A. Prepare a schedule for testing activities based on the schedule developed in Sections 27 15 13, 27 13 10, 27 13 14, and 27 13 24. Update testing schedule when changes in the cabling construction schedule occur.

B. Schedule both the Engineer of Record and a representative of the test equipment manufacturer for a demonstration of testing methods. Execute a demonstration of testing methods with aforementioned parties prior to 'production' testing activities. Test reports and acceptance testing will not be accepted without proof of methods demonstration.

## 3.2 FIELD QUALITY CONTROL

A. Complete testing as delineated below prior to system acceptance.

B. Permanently record all test results and presented in a format acceptable to the Owner or Engineer before system acceptance.

C. Remove and replace with new, at no cost to the Owner, any cables or conductors (copper or glass) failing to meet the indicated standards. The Owner will not accept the installation until testing has indicated a 100% availability of all cables and conductors or the Owner has approved any deviation from this requirement.

D. Calibrate test sets and associated equipment per the manufacturers printed instructions at the beginning of each day's testing and after each battery charge. Fully charge the test sets prior to each day's testing to ensure proper operation.

## 3.3 "PRE-INSTALLATION" CONTINUITY TESTING PROCEDURES

A. Ensure fiber continuity of all fiber strands of all cables prior to installation.

B. Reports from "pre-installation" continuity testing are not required to be submitted at project close out.

## 3.4 BACKBONE FIBER OPTIC CHARACTERIZATION TESTING

A. Test fiber optic passive links per "Base Bid Requirements" in Part 1 of this Section.

B. Precautions
1. Adhere to the equipment manufacturer's instructions during testing activities.

2. Prior to any testing activity or any measurements taken, complete the following activities:
   a. Ensure the test equipment is at room temperature – approximately 70 degrees F (e.g., if necessary, bring the test equipment in from outdoors and let it set for however long it takes to bring the test equipment to reach room temp).
   b. Clean all launch cords and system cords (if applicable) connectors and all adapters with a lint-free wipe and 90% (or higher) isopropyl alcohol.
3. Do not power off OTDR's light source during testing activity.
4. Do not remove launch cord from the OTDR's light source at any time (unless the testing is complete or the equipment is being put away for the evening, or during trouble shooting).
5. Do not bend the launch cord smaller than 20 times the cord diameter during testing activities (this may induce loss into the cord reducing the accuracy of the measurement).
6. Fully charge power source before each day's testing activity, if applicable.

C. "Post-Installation" Characterization Testing Procedures
1. Equipment settings / measurement parameters:
   a. Index of Refraction: match cable-under-test fiber parameters; default settings as follows:

| | | | |
|---|---|---|---|
| Multimode | Corning 50/125 Infinicor | 1.483 @ 850nm | 1.483 @ 1300nm |
| | SYSTIMAX 50/125 | 1.483 @ 850nm | 1.478 @ 1300nm |
| Singlemode | SYSTIMAX | 1.466 @ 1310nm | 1.467 @ 1550nm |
| | Corning SMF-28 | 1.4675 @ 1310nm | 1.4681 @ 1550nm |

   b. Pulse Width: multimode: 20ns; singlemode: 50 ns.

| | |
|---|---|
| Multimode 50/125 | 4 ns for cable lengths up to 500 meters |
| | 20 ns for cable lengths from 250 meters to 2,000 meters |
| Singlemode | 10 ns for cable lengths up to 2,000 meters |
| | 50 ns for cable lengths from 2,000 meters to 20 kilometers |

   c. Backscatter:
      1) Multimode: -67dB @ 850nm, -74dB @ 1300nm.
      2) Singlemode: -74dB @ 1310nm and 1550nm.
   d. Event Threshold: 0.05dB for both multimode and singlemode.
   e. Reflection Threshold:
      1) Multimode: -45dB.
      2) Singlemode: -60dB.
   f. Fiber Break/End-Of-Fiber: 3dB for both multimode and singlemode.
2. Waveform: The waveform shall be real-time/normal density.
3. Obtain measurements using a 'launch' cord connected to the test instrument and the cable-under-test.
   a. The fiber of the launch cord shall match the fiber of the cable-under-test in physical and performance parameters (such as type, core/cladding size, index of refraction, refractive profile). The fiber of the launch cord should match the fiber of the cable-under-test in manufacturer and product.
   b. The length of the launch cord shall be between 25 meters and 100 meters.
4. Review the results of each test and bring to the attention of the Engineer all fibers that do not meet the manufacturer's allowed loss for splices and connectors, or fibers that do not meet the length of the overall cable length.

D. Record Documents:
1. Test reports shall match the cable and fiber IDs as labeled in the field – i.e., the ID on the cable label/fiber port label shall be the same as what is associated with the electronic and printed test record.
2. The units for distance measurements (i.e., the "X" axis of the graph) shown on the print of the test measurements shall be feet.

3. For the traces, the x- and y-axis scales of a given cabling link shall be identical. Preferably, all reports shall be printed with identical scales on both x- and y-axis.
4. The launch cord must be shown in the trace of the printed test report.
5. Measurements shall carry a precision through one significant decimal place (minimum).
6. Each test report shall contain the following information (not necessarily in this order):
   a. Project name.
   b. General Contractor name / Telecommunications Installer name.
   c. Cable identifier, fiber number, and fiber type (e.g., "multimode").
   d. Measurement direction.
   e. Date measurement was obtained.
   f. Operator (name an company).
   g. Test equipment model and serial number(s).
   h. Set up parameters (minimum - pulse width, refractive index, event threshold.).
   i. Wavelength.
   j. OTDR trace.
   k. Length of fiber.
   l. Overall link loss.
7. For each passive cabling link, include either a schematic graphic or narrative accurately describing the test set up as a preface to the test reports. In other words, show the launch cord with length, expected events with distances, etc. This information will eliminate many questions the Engineer will have while reviewing the reports.

## 3.5 BACKBONE FIBER OPTIC PASSIVE LINK INSERTION LOSS TESTING

A. Test fiber optic passive links per "Base Bid Requirements" in Part 1 of this Section.

B. Launch Conditions:
1. For passive link insertion loss testing for multimode fibers, the modal launch condition from the light source shall be characterized as Category 1 per OFSTP-14.
2. For passive link insertion loss testing of singlemode fibers:
   a. Use the launch conditions, as described in FOTP-78.
   b. Employ a method to remove high-order propagating modes, as described in FOTP-77.

C. Test Methods:
1. The passive link insertion loss testing of multimode fibers shall be performed according to "Test Method B: One Jumper Reference", per OFSTP-14, for 'permanent' links, and shall be performed according to "Test Method C: Three Jumper Reference", per OFSTP-14, for 'channel' links.
2. The passive link insertion loss testing of singlemode fibers shall be performed according to "Test Method A.1: One Jumper Measurement", per OFSTP-7.

D. Precautions
1. Adhere to the equipment manufacturer's instructions during testing activities.
2. Prior to any testing activity or any measurements taken:
   a. Ensure the test equipment is at room temperature – approximately 70 degrees F (e.g., if necessary, bring the test equipment in from outdoors and let it set for about 15 minutes or for however long it takes to bring the test equipment to reach room temp).
   b. Power on the light source and power meter for at least 5 minutes.
   c. Clean all test cords & system cords (if applicable) connectors and all adapters with a lint-free wipe and 90% (or higher) isopropyl alcohol.
3. Do not power off light source or the power meter during testing activity.

4. Do not remove Test Cord #1 from the light source at any time (unless the testing is complete or the equipment is being put away for the evening).
5. Do not bend the test cords smaller than 20 times the cord diameter (this may induce loss into the cord reducing the accuracy of the measurement).
6. Fully charge power sources before each day's testing activity.

E. Passive Link Insertion Loss Testing Procedures

1. Test Equipment Set Up
   a. Follow the test equipment manufacturer's initial adjustment and set up instructions.
   b. If the power meter has a Relative Power Measurement Mode, select this mode.
   c. If the meter can display power levels in dBm, select this unit of measurement to simplify subsequent calculations.
   d. Set the light source and power meter to the same wavelength.
2. Test Cord Performance Verification
   a. Connect Test Cord #1 between the light source and the power meter.
   b. The value displayed on the power meter is the reference power ($P_{ref}$) measurement. If the power meter has a relative power measurement mode, enter this reference power measurement ($P_{ref}$) value into the meter. If it does not, hand-write $P_{ref}$ onto the record documents for future reference.
   c. Disconnect Test Cord #1 from the power meter. Do not disconnect Test Cord #1 from the light source.
   d. Connect the 'open' end of Test Cord #1 to an adapter (of matching connector type). Connect one end of Test Cord #2 to the adapter and the other end of Test Cord #2 to the power meter.
   e. The value displayed on the power meter is the power measurement ($P_{sum}$). If the power meter is in Relative Power Measurement Mode, the meter reading represents the test cord #2 connection attenuation. If the meter does not have a Relative Power Measurement Mode, perform the following calculation to determine the connection attenuation:
      1) If $P_{sum}$ and $P_{ref}$ are in the same logarithmic units (dBm, dBu, etc): Connection Attenuation (dB) = $\left| P_{sum} - P_{ref} \right|$.
      2) If $P_{sum}$ and $P_{ref}$ are in watts: Connection Attenuation (dB) = $\left| 10 \times \log_{10} [P_{sum}/P_{ref}] \right|$.
      3) The measured connection attenuation must be less than or equal to the value found in Table 3 (below).
   f. Flip the ends of Test Cord #2 so that the end connected to the power meter is now connected to the adapter, and the end connected to the adapter is now connected to the power meter.
   g. The meter reading is the reversed Power Measurement ($P_{sum}$). Perform the proper calculations if not using Relative Power Measurement Mode.
   h. Verify that both connection attenuation measurements are less than or equal to the value found in the following table:

| | ST or SC Cord | Mini-Connector Cord |
|---|---|---|
| Multimode (50/125) | 0.50 dB Max | 0.20 dB Max |
| Singlemode | 0.55 dB Max | 0.30 dB Max |

i. If both measurements are found to be less than or equal to the values found in Table 1, test cord #1 is acceptable for testing purposes. Unacceptable attenuation measurements may be attributable to test cord # or test cord #2. Examine each cord with a portable microscope and clean, polish, or replace if necessary.

j. Repeat this test procedure from the beginning reversing the test cords in order to verify the performance of test cord #2.

3. Determine the Launch Category of the Light Source

a. The launch category of a light source can be determined by measuring its Coupled Power Ratio (CPR). The CPR is a measurement of the modal power distribution launched into a multimode fiber. A light source that launches a higher percentage of its power into the higher order modes of a multimode fiber produces a more over-filled condition and is classified as a lower Category than a light source that launches more of its power into just the lower order modes producing an under-filled condition. Under-filled conditions result in lower link attenuation, while over-filled conditions produce higher attenuation. Therefore, adjusting the acceptable link attenuation to compensate for a light source's launch characteristics increases the accuracy of the test procedure.

b. Provide two test cords, one multimode (Test Cord #1) and one singlemode (Test Cord #2). Both cords shall be directly terminated on connectors that are compatible with the light source and power meter.

1) The fiber of the multimode test cord shall have the core diameter and numerical aperture nominally equal to those of the permanent link.

2) The fiber of the singlemode test cord shall contain Class IVa singlemode fiber, with a mode field diameter of 5.0□m ±0.5□m for 850nm tests and 9.0□m ±1.0□m for 1300nm tests.

c. Connect test cord #1 between the light source and the power meter. Avoid placing bends in the cord that are less than 4 inches in diameter.

d. The meter reading is the Reference Power Measurement ($P_{ref}$). If the power meter has a Relative Power Measurement Mode, enter the Reference Power Measurement ($P_{ref}$) value into the meter. If it does not, hand-write $P_{ref}$ for future reference.

e. Disconnect test cord #1 from the power meter. Do not disconnect test cord #1 from the light source.

f. Connect test cord #2 between the power meter and test cord #1, using an appropriate adapter between the test cords: Test cord #2, the singlemode cord, shall include a high order mode filter. This can be accomplished by twice wrapping the cord around a 1.2" diameter (30-mm) mandrel.

g. The meter reading is the Power Measurement ($P_{sum}$). If the power meter is in Relative Power Measurement Mode, the meter reading represents the CPR. If the meter does not have a Relative Power Measurement Mode, perform the following calculation to determine the CPR:

1) If $P_{sum}$ and $P_{ref}$ are in the same logarithmic units (dBm, dBu, etc): CPR (dB) = $\left| P_{sum} - P_{ref} \right|$.

2) If $P_{sum}$ and $P_{ref}$ are in watts: CPR (dB) = $\left| 10 \times \log_{10} [P_{sum}/P_{ref}] \right|$.

Coupled Power Ratio (CPR) in dB, for 50/125µm Fiber:

| | Cat-1 Overfilled | Cat-2 | Cat-3 | Cat-4 | Cat-5 Underfilled |
|---|---|---|---|---|---|
| 850nm source | 20 – 24 | 16 – 19.9 | 11 – 15.9 | 7 – 10.9 | 0 – 5.9 |
| 1300nm source | 16 – 21 | 12 – 15.9 | 8 – 11.9 | 4 – 7.9 | 0 – 3.9 |

4. Multimode Insertion Loss Measurement
   a. After setting up the test equipment, verifying the performance of the test cords, and determining the light source's CPR, the insertion loss of the passive link segments can be measured.
   b. Connect test cord #1 between the light source and the power meter.
   c. The meter reading is the Reference Power Measurement ($P_{ref}$). If the power meter has a Relative Power Measurement Mode, enter the Reference Power Measurement ($P_{ref}$) value into the meter. If it does not, hand-write $P_{ref}$ for future reference and to be included in the Record Documents.
   d. Disconnect test cord #1 from the power meter. Do not disconnect test cord #1 from the light source.
   e. Connect test cord #1 to the passive link segment 'input'.
   f. At the opposite end of the passive link segment, connect test cord #2 to the link segment 'input' and the power meter.
   g. The meter reading is the Power Measurement ($P_{sum}$). If the power meter is in Relative Power Measurement Mode, the meter reading represents the insertion loss. If the meter does not have a Relative Power Measurement Mode, perform the following calculation to determine the insertion loss:
      1) If $P_{sum}$ and $P_{ref}$ are in the same logarithmic units (dBm, dBu, etc): Link Segment Attenuation (dB) = $\left| P_{sum} - P_{ref} \right|$.
      2) If $P_{sum}$ and $P_{ref}$ are in watts: Link Segment Attenuation (dB) = $\left| 10 \times \log_{10} [P_{sum}/P_{ref}] \right|$.
   h. Record $P_{sum}$ for inclusion into the Record Documents. Refer to Records (ref. PART 3: EXECUTION) for all of the information to record.
5. Singlemode Insertion Loss Measurement
   a. After setting up the test equipment and verifying the performance of the test cords, the insertion loss of the passive link segments can be measured.
   b. Connect test cord #1 between the light source and the power meter.
   c. The meter reading is the Reference Power Measurement ($P_{ref}$). If the power meter has a Relative Power Measurement Mode, enter the Reference Power Measurement ($P_{ref}$) value into the meter. If it does not, hand-write $P_{ref}$ for future reference and to be included in the Record Documents.
   d. Disconnect test cord #1 from the power meter. Do not disconnect test cord #1 from the light source.
   e. Connect test cord #1 to the passive link segment 'input'.
   f. At the opposite end of the passive link segment, connect test cord #2 to the link segment 'input' and the power meter.
   g. The meter reading is the Power Measurement ($P_{sum}$). If the power meter is in Relative Power Measurement Mode, the meter reading represents the insertion loss. If the meter does not have a Relative Power Measurement Mode, perform the following calculation to determine the insertion loss:
      1) If $P_{sum}$ and $P_{ref}$ are in the same logarithmic units (dBm, dBu, etc): Link Segment Attenuation (dB) = $\left| P_{sum} - P_{ref} \right|$.
      2) If $P_{sum}$ and $P_{ref}$ are in watts: Link Segment Attenuation (dB) = $\left| 10 \times \log_{10} [P_{sum}/P_{ref}] \right|$.
   h. Record $P_{sum}$ for inclusion into the Record Documents. Refer to Records (ref. PART 3: EXECUTION) for all of the information to record.
6. Acceptable Measurement Values
   a. Any cabling links failing to meet the criteria described in this specification shall be removed and replaced, at no cost to the Owner, with cables that prove, in testing, to meet the minimum requirements.
   b. The general insertion loss equation for any link segment is as follows:
      1) Insertion loss = <cable loss> + <connection loss> + <splice loss>

+ <CPR adjustment>.

2) Note: A connection is defined as the joint made by two mating fibers terminated with remateable connectors (e.g., ST, SC, etc).

c. 50/125µm Multimode Insertion Loss Coefficients

1) Cable Loss = Cable Length (km) x (3.0 dB/km @ 850-nm or 1.0B/km @ 1300-nm).

2) Connection Loss (ST or SC Connectors) = (Connections x 0.4 dB) + 0.42 dB.

3) Connection Loss (Other mini-connectors) = (Connections x 0.2 dB) + 0.24 dB.

4) Splice Loss = Splices x (0.05 dB for fusion or 0.10 dB for mechanical).

5) CPR Adjustment = See following table:

| | Cat-1 | Cat-2 | Cat-3 | Cat-4 | Cat-5 |
|---|---|---|---|---|---|
| Links with ST or SC Connectors | +0.50 | 0.00 | -0.25 | -0.50 | -0.75 |
| Links with mini-connectors | +0.25 | 0.00 | -0.10 | -0.20 | -0.30 |

d. Singlemode Insertion Loss Coefficients

1) Cable Loss = Cable Length (km) x (0.50 dB/km @ 1310-nm or 0.50 dB/km @ 1550-nm).

2) Connection Loss (ST or SC Connectors) = (Connections x 0.44 dB) + 0.42 dB.

3) Connection Loss (Other mini-connectors) = (Connections x 0.24 dB) + 0.24 dB.

4) Splice Loss = Splices x (0.07 dB for fusion or 0.15 dB for mechanical).

5) CPR Adjustment = Not applicable for singlemode.

F. Record Documents:

1. All cable and fiber IDs of the test reports shall match the IDs as labeled in the field – i.e., the ID on the cable label/fiber port label shall be the same as what is entered into the stored test result in the power meter.
2. Measurements shall carry a precision through one significant decimal place (minimum).
3. Each test report shall contain the following information (not necessarily in this order):
   a. Project name and address.
   b. General Contractor name / Telecommunications Installer name.
   c. Operator's name(s).
   d. Date of measurement.
   e. Test equipment - manufacturer, model, and serial number.
   f. Cable identifier, fiber and fiber type.
   g. Measurement direction.
   h. Wavelength, and.
   i. Measured loss values.

## 3.6 BACKBONE TWISTED PAIR CABLING TESTING REQUIREMENTS AND PROCEDURES

A. Testing Requirements

1. Test backbone multipair cabling per "Base Bid Requirements" in Part 1 of this Section.

2. The installation will be accepted when testing has indicated a 100% availability of all terminated pairs or the Owner has approved any deviation from this requirement.

B. Testing Procedures
1. Test wire map and continuity for all pairs.
2. Test length for 2% of pairs of each cable. None of the pairs tested for length shall be of the same 25-pair binder group.

C. Record Documents:
1. All cable and pair IDs of the test reports shall match the IDs as labeled in the field – i.e., the ID on the cable label/termination label shall be the same as what appears on the test reports.
2. Measurements shall carry a precision through no significant decimal place.
3. Each test report shall contain the following information (not necessarily in this order):
   a. Project name and address.
   b. General Contractor name / Telecommunications Installer name.
   c. Operator's name(s).
   d. Date of measurement.
   e. Test equipment - manufacturer, model, and serial number.
   f. Cable identifier and pair numbers.
   g. Overall test result, and.
   h. Measured values of minimum requirements.

## 3.7 HORIZONTAL CATEGORY 6 TESTING PROCEDURES

A. Precautions
1. Adhere to the equipment manufacturer's instructions during all testing.
2. Prior to any testing activity or any measurements taken, ensure the test equipment is at room temperature – approximately 70 degrees F (e.g., if necessary, bring the test equipment in from outdoors and let it set for about 15 minutes or for however long it takes to bring the test equipment to reach room temp).
3. Fully charge power sources before each day's testing activity.

B. Test Equipment Set Up
1. Set up the tester to perform a full Category 6 test, as a Permanent Link configuration.
2. If the tester has the capability, set the cable type as product specific setting. If not, set as generic Category 6.
3. Set the tester to save the full test results (all test points, graphs, etc.).
4. Save the test results with the associated cable link identifier to match that as specified in Section 27 15 13.
5. Calibrate the test set per the manufacturers instructions.

C. Acceptable Test Result Measurements
1. Links which report a Fail, Fail* or Pass* for any of the individual tests shall result in an overall link Fail. All individual test results must result in a Pass to achieve an overall Pass.
2. Any reconfiguration of link components required as a result of a test Fail, must be re-tested for conformance.
3. Any cabling links failing to meet the criteria described in this specification shall be removed and replaced, at no cost to the Owner, with cables that prove, in testing, to meet the minimum requirements.

4. Minimum measurement requirements:

| | |
|---|---|
| Wire Map | All pairs of the cabling link shall be continuous and terminated correctly at both ends. No exceptions shall be accepted. |
| Length | The maximum acceptable electrical length measurements for any cabling link measured under a Permanent Link configuration shall be 94 meters, including test cords. |
| Insertion Loss | The acceptable insertion loss measurements for any Category 6 cabling link shall be no greater than that as listed in TIA/EIA-568B.2 Addendum 1. |
| Worst Pair-to-Pair Near End CrossTalk (NEXT) Loss | The acceptable worst pair-to-pair NEXT loss for any Category 6 cable shall be no greater than that as listed in TIA/EIA-568B.2 Addendum 1. |
| Power Sum NEXT Loss | The acceptable power sum PS-NEXT loss for any Category 6 cable shall be no greater than that as listed in TIA/EIA-568B.2 Addendum 1. |
| Worst Pair-to-Pair ELFEXT and FEXT Loss | The acceptable worst pair-to-pair ELFEXT and loss for any Category 6 cable shall be no greater than that as listed in TIA/EIA-568B.2 Addendum 1. |
| Power Sum ELFEXT and FEXT Loss | The acceptable PS-ELFEXT and loss for any Category 6 cable shall be no greater than that as listed in TIA/EIA-568B.2 Addendum 1. |
| Return Loss | The acceptable return loss measurements for any Category 6 cable shall be no greater than that as listed in TIA/EIA-568B.2 Addendum 1. |
| Propagation Delay and Delay Skew | The acceptable propagation delay and delay skew measurements for any Category 6 cable shall be no greater than that as listed in TIA/EIA-568B.2 Addendum 1. |

D. Record Documents: For each Horizontal Category 6 test measurement, record the following information:

1. Project name and address.
2. General Contractor name / Telecommunications Installer name.
3. Operator's name(s).
4. Date of measurement.
5. Ambient temperature.
6. Test equipment - manufacturer, model, and serial number.
7. Cable identifier.
8. Overall test result, and
9. Measured values of minimum requirements.

**END OF SECTION**

# SECTION 27 11 00

# TELECOMMUNICATIONS ROOMS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes: Build out of telecommunications rooms and spaces.

B. Products Specified, Furnished, and Installed Under Another Section:
1. Electrical service (120V and 208V circuits and devices).
2. Conduit, device boxes, and sleeves.

C. Products Furnished and Installed by the Owner: Network switches, UPS systems, power strips, and telephone handsets

D. 24BRelated Divisions
1. Comply with the Related Sections paragraph of Section 27 00 00.
2. Consult other Divisions, determine the extent and character of related work, and properly coordinate work specified herein with that specified elsewhere to produce a complete and operable system.
3. General and Supplementary Conditions.
4. Drawings, general provisions of the Agreement, and Division 1 apply to this Section.

### 1.2 REFERENCES

A. Comply with the References requirements of Section 27 00 00.

B. In additional to those codes, standards, etc., list in 27 00 00, comply with the latest edition of the following applicable specifications and standards except as otherwise shown or specified: ANSI/EIA-310-D-1992 Racks, Panels And Associated Equipment.

### 1.3 DEFINITIONS

A. Refer to the Definitions requirements of Section 27 00 00.

### 1.4 SYSTEM DESCRIPTION

A. Telecommunications Rooms house the following functions:
1. Data backbone crossconnect field (fiber terminations).
2. Voice backbone crossconnect field (UTP terminations).
3. Data system equipment (distributed switch).
4. Horizontal termination field – both voice and data – of cabling served from this room (refer to floor plans for area served).
5. Interconnection between the data system equipment and the horizontal termination field.

B. Base Bid Work
1. Telecommunications Room build out includes the following work:
   a. Preconstruction Submittals.
   b. Plywood backboards.
   c. Rack bays (equipment racks, vertical management sections, anchoring, and bracing).
   d. Cable, wire and patch cord management.
   e. Overhead cable support.

f. Seismic bracing.
g. Identification tags and labeling.
h. Record Documents.
i. Warranty.

## 1.5 SUBMITTALS

A. Refer to Submittals of Section 27 00 00 for procedural, quantity, and format requirements.

B. Pre-Construction Submittal Requirement: Submit the following prior to the start of construction.
1. Product Data Submittal: Submit product data on products listed in this section and products not listed in this section to be installed related to this section.
2. Sample Submittal: Submit sample of equipment rack label.
3. Seismic Calculations: Rack anchorage into concrete flooring with overall rack bracing.
4. Schedule Submittal: Submit proposed schedule of work (this schedule may be combined with the schedule developed for the 27 00 00 series Sections).
5. Shop Drawings Submittal: Consisting of proposed changes to room plans.

C. Submittal Requirements at Closeout:
1. As-Built Drawings.
2. O & M Manuals.

## 1.6 QUALITY ASSURANCE

A. Refer to Quality Assurance requirements of Section 27 00 00.

## 1.7 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Refer to Product Delivery, Storage and Handling requirements of section 27 00 00.

## 1.8 WARRANTY

A. Refer to Warranty requirements of section 27 00 00.

# PART 2 - PRODUCTS

## 2.1 EQUIPMENT RACK, FLOOR-STANDING

A. Application: Suitable for the support of cable termination devices, management devices, common communications equipment, and other similar equipment, installed onto floor.

B. Material: High strength, lightweight 6061-T6 aluminum, extrusion construction.

C. Channel:
1. Size: The mounting channels shall be 3" deep by 1.265" wide with a 0.17" thick web.
2. Flange: The mounting channels shall have front and back mounting flanges ("double sided"). The flanges shall be 0.25" thick, and shall have mounting holes front and back.

3. Mounting Holes: The hole pattern shall be industry standard spaced at 5/8" - 5/8" - 1/2", compatible with ANSI/EIA-310-D (1992) standard. The mounting holes shall be pre-threaded as #12-24 rolled threading.

D. Assembled Rack: The rack shall come complete with base angles (3.5" high by 6" deep by .375" thick) and top angles (1.5" high by 1.5" deep by .375" thick). The assembled rack shall be 8'-0" high (overall) by 19" mounting width (20.25" wide overall), and shall contain 51 EIA mounting spaces.

E. Include required accessories, such as floor installation kit, etc. for a complete installation.

F. Manufacturer, or equal: CPI, #46353-715, 8'-0"H x 19" equipment rack, black.

## 2.2 EQUIPMENT RACK, WALL-MOUNTED

A. Application: Suitable for the support of cable termination devices, management devices, common communications equipment, and other similar equipment, installed onto wall.

B. Mounting Holes: The hole pattern shall be industry standard spaced at 5/8" - 5/8" - 1/2", compatible with ANSI/EIA-310-D (1992) standard. The mounting holes shall be pre-threaded as #12-24 rolled threading.

C. Assembled Rack: The rack shall come complete with wall bracket and equipment mounting rails. The assembled rack shall be 25" deep by 19" mounting width, and shall contain either 27 or 41 EIA mounting spaces (RMU).

D. Manufacturer: CPI
1. #11807-725; 49"H x 19" x 25" deep / 27 RMU wall-mounted equipment rack, black.
2. #11792-725; 73.5"H x 19" x 25" deep / 41 RMU wall-mounted equipment rack, black.

## 2.3 VERTICAL MANAGEMENT SECTION, FOR FLOOR-STANDING RACK

A. Application: Suitable for cable routing (back) & cord slack storage (front) vertically from the bottom of the rack to the top. The vertical management sections shall be double sided (i.e., the management section shall have covered cable guides on the front and flip-retainers on the rear).

B. Size & Capacity: 8'-0" high by 6" wide, with 5-1/3" deep cable storage capacity in back and 6" cord storage capacity in front.

C. Mounting: The vertical management section shall have matching bolt holes for attachment to the rack.

D. Color: black (guides and cover).

E. Manufacturer, or equal: CPI: #30162-715, vertical mngt section, 8'-0"H x 6"W, double sided.

## 2.4 HORIZONTAL MANAGEMENT PANEL

A. Application: Suitable for installation into equipment rack for cord routing (front). The horizontal management panel shall match (and fully integrate with) the vertical management sections.

B. Size & Capacity: 1U high, with hinged/removable cover and pass through capacity. Management panel shall be double sided.

C. Color: black.

D. Manufacturer, or equal: CPI: #30529-719; horizontal cable manager, 1U, double sided.

## 2.5 CABLE BASKET

A. Refer to Section 27 11 00 for specifications of cable basket.

## 2.6 CABLE RUNWAY

A. Cable Runway Straight Sections
1. Application: Suitable for the support & management of communications cables, either overhead or mounted vertically on a wall. Also overhead equipment racks bracing.
2. Material (both stringer and rung): Steel tube, rectangular, 1-1/2" by 3/8" by 0.65" wall thickness.
3. Rungs: 12" on center, welded to stringer.
4. Size: length: 9' 11-1/2" (cut–to–fit); width: refer to Drawings.
5. Manufacturer, or equal: CPI
   a. #10250-709, 9" wide universal cable runway, black.
   b. #10250-712, 12"wide universal cable runway, black.
   c. #10250-718, 18"wide universal cable runway, black.
   d. #10250-724, 24"wide universal cable runway, black.

B. Cable Runway Sweep Fittings
1. Material (both stringer and rung): Steel tube, rectangular, 1-1/2" by 3/8" by 0.65" wall thickness.
2. Manufacturer, or equal: CPI
   a. #10822-712, horizontal sweep fitting for 12" wide cable runway, black.
   b. #10822-718, horizontal sweep fitting for 18" wide cable runway, black.
   c. #10723-712, vertical outside sweep fitting for 12" wide cable runway, black.
   d. #10723-718, vertical outside sweep fitting for 18" wide cable runway, black.
   e. #10724-712, vertical inside sweep fitting for 12" wide cable runway, black.
   f. #10724-718, vertical inside sweep fitting for 18" wide cable runway, black.

C. Cable Runway Installation Accessories
1. Refer to Drawings for additional information and instances for installation.
2. Manufacturer, or equal: CPI
   a. #11301-001, butt splice kit.
   b. #11313-001, 45-degree butt splice kit.
   c. #11314-001, 90-degree butt splice kit.
   d. #11302-001, junction splice ("T") kit.
   e. #10608-001, vertical wall bracket kit.
   f. #10642-001, end caps.
   g. #11421-712, wall angle support kit for 12" wide cable runway, black.
   h. #11421-718, wall angle support kit for 18" wide cable runway, black.
   i. #11421-724, wall angle support kit for 24" wide cable runway, black.
   j. #11312-712, triangle support kit for 9" and 12" wide cable runway, black.

k. #11312-718, triangle support kit for 12" and 18" wide cable runway, black.
l. #11770-712, end closing kit for 12" wide cable runway, black.
m. #11770-718, end closing kit for 18" wide cable runway, black.
n. #11770-724, end closing kit for 24" wide cable runway, black.
o. #10595-712, rack-to-runway attachment kit, for 9" or 12" wide runway, black.
p. #10595-718, rack-to-runway attachment kit, for 18" wide runway, black.

## 2.7 LABEL PLATES, FOR EQUIPMENT RACKS

A. Application: Label plate shall be suitable to affix onto top angle of equipment rack.

B. Label plate shall be 'engrave-able' stock melamine plastic laminate substrate.
1. Size (minimum): 1/2 inch high by six inches long by 1/16-inch thick.
2. Color: Black.

C. Lettering shall be engraved, shall be 1/8" high, and shall be white.

# PART 3 - EXECUTION

## 3.1 GENERAL

A. Comply with the General Execution requirements of Section 27 00 00.

## 3.2 INSTALLATION

A. Rack Bays
1. Equipment Racks, Floor-Standing
a. Provide parts and accessories required to complete each rack.
b. Anchor racks to the floor using methods (concrete anchors) approved by both structural engineer and DSA. Brace racks overhead to cable runway where shown on the Drawings.
2. Equipment Racks, Wall-Mounted
a. Provide parts and accessories required to complete each rack.
b. Anchor racks to the wall using fasteners approved by DSA.
3. Vertical Management Sections
a. Provide vertical management sections as shown on Drawings. If not shown, default shall be one vertical management section between each rack and at either end of the bay.
b. Bolt vertical management sections to the equipment racks at the points designed by the manufacturer and per the manufacturer's installation instructions.
c. Install support devices (e.g., brackets, threaded rod with strut, etc.) per the manufacturer's instructions and fastened to the wall or ceiling using appropriate fasteners.
4. Tolerances:
a. Equipment Rack, Floor-Standing: Field verify dimensions to establish proper clearances as follows:
1) Front: 40" clearance from channel's front mounting flange.
2) Back: 57" clearance from channel's back mounting flange.
b. Equipment Rack, Wall-Mounted: Field verify dimensions to establish proper clearances as follows:
1) Front: 40" clearance from channel's front mounting flange.
2) Side: 10" between racks and between rack and wall.
3) Bottom: 24" clearance from floor to bottom of rack.

c. Provide the correct amount of space between each rack for proper installation (according to manufacturer's written instructions) of the vertical management sections.

5. Accessories: Furnish one bag of 50 mounting screws per equipment rack.

B. Overhead Cable Support
1. Provide overhead cable support as shown on the Drawings for use to support cables and store cable slack within telecommunications rooms between the exit sleeves/distribution conduits and the rack bay.
2. Provide parts required to complete the installation (e.g., trapeze, junction nuts, etc.).

C. Vertical Cable Support
1. Provide vertical cable support at the locations as shown on the Drawings for use to support cables routing vertically from conduits/sleeves to the overhead cable support.
2. Provide parts required to complete the installation (e.g., vertical mounting brackets, bolts, etc.).
3. If cable runway is used, install the runway such that the rungs are facing outward (the greater distance from the rung to the stringer edge is facing inward). If cable basket is used, install the basket with spacers such that the mesh is spaced 1/2" from the wall.

## 3.3 LABELING

A. General Requirements: Labeling and identifier assignment shall conform to TIA/EIA-606-A Administration Standard and as approved by Owner before installation.

B. Equipment Rack Label Requirements: Provide one label plate per rack. Permanently affix label plate and position the label plate centered on the rack's front top angle.

C. Identifier Assignment: Equipment Racks
1. Prefix: "RACK."
2. First field: the telecommunications room identity; for example: "TDB".
3. Second field: the rack number; for example: "01".
4. Example; "RACK TDB–01."

**END OF SECTION**

# SECTION 27 13 10

# TELECOMMUNICATIONS BACKBONE ISP CABLING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes: Backbone ISP (indoor) twisted pair cabling and fiber optic cabling.

B. Related Sections
1. Comply with the Related Sections paragraph of Section 27 00 00 Telecommunications Basic Requirements.
2. 27 05 28 Telecommunications Building Pathways.
3. 27 08 00 Telecommunications Testing.

### 1.2 REFERENCES

A. Comply with Section 27 00 00 References requirements.

### 1.3 DEFINITIONS

A. Refer to Section 27 00 00 for Definitions.

B. In addition, the following list of terms as used in this specification shall be defined as follows:
1. "CMP": Communications Media Plenum.
2. "CMR": Communications Media Riser.
3. "ISP": Inside Plant.
4. "MM": Multimode.
5. "PIC": Plastic Insulated Conductor.
6. "OFNP": Optical Fiber Non-conductive Plenum, plenum rating.
7. "OFNR": Optical Fiber Non-conductive Riser, non-plenum riser rating.
8. "OFN": Optical Fiber Non-conductive, general purpose indoor rating.
9. "PE": Polyethylene.
10. "PVC": Polyvinyl Chloride.
11. "SM": Singlemode.

### 1.4 SYSTEM DESCRIPTION

A. Refer to Section 27 00 00for description of the project and building.

B. Work Provided Under Other Sections
1. Telecommunications Pathways (Cable Basket, Conduits, Riser Sleeves, etc.). Refer to the Drawings for size/capacity and route information.
2. Buildout of the telecommunications rooms (e.g., backboards, overhead and vertical cable runway, etc.). Refer to the Drawings for buildout information.

C. Base Bid Work
1. Provide engineering, labor, materials, apparatus, tools, equipment, and transportation required to make a complete working telecommunications backbone twisted pair and fiber optic cabling system installation described in these specifications.

2. Consider backbone cabling shown on the Drawings as base bid work, unless otherwise noted. This includes terminations at both ends, unless otherwise noted.
3. In general, the base bid work includes:
   a. Preconstruction Submittals.
   b. Backbone ISP (riser) twisted pair (copper) cables and terminations.
   c. Backbone ISP fiber optic cables and terminations.
   d. Cable management.
   e. Crossconnects.
   f. Cable identification tags and system labeling.
   g. Record Documents.
   h. Warranty.

## 1.5 SUBMITTALS

A. Comply with Submittal procedural, quantity, and format requirements of Section 27 00 00.

B. Preconstruction Submittal Requirements:
   1. Product Data Submittal, indicating conformance with NEC, UL, TIA/EIA listings, certifications, and specifications.
   2. Labeling Submittal, consisting of proposed labeling scheme for backbone cables and backbone terminations.
   3. Schedule Submittal, consisting of proposed schedule of work. This schedule may be combined with the schedule developed for 27 00 00 series Sections.
   4. Shop Drawings Submittal, consisting of proposed changes to cable routing, or termination locations/configurations.

C. Submittal Requirements at Closeout:
   1. As-Built Drawings.
   2. Crossconnection records/cut sheets.
   3. O & M Manuals.

## 1.6 QUALITY ASSURANCE

A. Comply with Quality Assurance requirements of Section 27 00 00

B. Contractor Qualifications: In addition to the Contractor Qualifications requirements of Section 27 00 00, the Contractor shall be manufacturer certified to install the proposed and submitted cabling system and to provide an extended warranty. Provide satisfactory evidence of certification in the form of a current letter or certificate from the manufacturer as part of the bid submission.

## 1.7 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Comply with Delivery, Storage and Handling requirements of Section 27 00 00.

## 1.8 WARRANTY

A. Telecommunications cabling system, as specified in this section, shall carry a 15 year (minimum) extended system warranty. This extended warranty shall cover parts and labor for the duration of the extended warranty. This extended warranty shall also cover electrical performance of the twisted pair cabling system to the specific category per ANSI/TIA/EIA-568-B performance criteria for backbone cabling.

## PART 2 - PRODUCTS

### 2.1 SHIELDED TWISTED PAIR CABLES – NON-PLENUM

A. Application:
1. Cable shall be suitable for indoor installation, between floors in vertical riser system, under access flooring, and through overhead ceiling space (in cable tray, conduit, & hangers).
2. Each and every cable run shall be a continuous single cable, homogenous in nature. Splices are not permitted anywhere.
3. Cable shall be twisted pair PIC type cable, air core, with an "ALVYN" sheath. Cable shall be compatible with Bell System type "ARMM".

B. Conductors:
1. Conductors shall be 24 AWG annealed solid copper.
2. Conductors shall be fully insulated. Insulation shall consist of an inner layer of expanded polyolefin, covered with an outer layer (skin) of solid PVC.
3. Conductors shall be twisted into pairs. Twisted pairs are stranded into 25-pair bundles and into units (and super units, if required by pair count).
4. Color Coding: Twisted pairs and units (supper units, if necessary) shall be individually color coded to industry standards (ANSI/ICEA Publication S-80-576, and EIA-230).

C. Core & Sheath:
1. Cable core (twisted pairs) shall have a tape applied longitudinally (wrapped around it's entirety). Tape Material: non-hydroscopic polypropylene film, or equivalent.
2. Sheath Type: "ALVYN". Sheath shall consist of an inner shield and an outer jacket.
   a. Shield: Aluminum, 0.008", corrugated tape applied longitudinally, with an overlap.
   b. Jacket: Flame-retardant PVC, adhesively bonded to shield.
3. Cable shall be NEC rated as CMR, and UL listed as such.

D. Performance: Electrical performance of the twisted pairs and overall cable shall comply with TIA/EIA-568-B Part 2 requirements for Category 3 UTP cabling.

E. Manufacturers:
1. General Cable Air Core Cables "Foam Skin ALVYN Riser Cable" series cables.
2. SYSTIMAX ARMM series cables.

### 2.2 FIBER OPTIC CABLES – NON-PLENUM

A. Application:
1. Cable shall be suitable for indoor installation, between floors in vertical riser system, under access flooring, and through overhead ceiling space (in cable tray, conduit, & hangers).
2. Cable shall exhibit stable performance in a building environment. The optical transmission performance of the fiber shall not be significantly affected by environmental fluctuations, installation, or aging.
3. Materials used in the cable shall not emit hydrogen in quantities that will increase attenuation.

B. 50/125 μm Multimode fiber strands shall meet or exceed the following geometry criteria:
1. Core diameter = 50 μm, ±3.0 μm.
2. Cladding diameter = 125 μm, ±1.0 μm.
3. Core/Cladding Concentricity = ≤ 3 μm.
4. Minimum Tensile Strength = 100,000 psi.

C. 50/125 μm Multimode fiber strands shall meet or exceed the following performance criteria:
1. Attenuation = 3.5 dB/km at 850 nm and 1.5 dB/km at 1300 nm wavelengths, maximum.
2. Overfilled Bandwidth = 500 MHz•km at 850 nm and 500 MHz•km at 1300 nm wavelengths, minimum.
3. Laser Bandwidth = 2,000 MHz•km at 850 nm and 500 MHz•km at 1300 nm wavelengths, minimum.

D. Singlemode fiber strands shall meet or exceed the following geometry criteria:
1. Core diameter = 8.3 μm.
2. Mode field diameter = 8.8 μm, ±0.5 μm.
3. Cladding diameter = 125 μm, ±1.0 μm.
4. Core/Cladding Concentricity = ≤ 0.8 μm.
5. Minimum Tensile Strength = 100,000 psi.

E. Singlemode fiber strands shall meet or exceed the following performance criteria:
1. Attenuation = 0.4 dB/km at 1310 nm and 0.3 dB/km at 1550 nm wavelengths, maximum.
2. Cutoff wavelength = 1260 nm.
3. Dispersion = 3.5 ps/nm•km at 1285-1330 nm.

F. Buffering:
1. Each fiber shall be completely covered with a "primary coating" (acrylate material). This shall constitute the "fiber strand".
2. Each fiber strand shall be fully covered with a flame retardant thermoplastic material (material = PVC, or equivalent thermoplastic). This shall constitute the "buffered strand" (tight buffer type), and shall have a diameter of 0.9 mm.
3. Buffered Strands: Buffered strands shall be individually color coded to meet the requirements of ANSI/TIA/EIA-598-A-1995. (Also, ref. ANSI/ICEA S-87-640-1992).

G. Cable Sheath:
1. Strength Element: The cable shall have an internal strength element such as aramid yarn (e.g., Kevlar).
2. Tensile Strength: The cable shall have a 150-lb, minimum, rated load.
3. Outer Jacket: The cable shall have a seamless outer jacket (material = PVC, or equivalent) applied to and completely covering the internal components (fiber strands, strength element, other).
4. Flame Rating: The cable shall be NEC (Article 770) rated as OFNR, and UL listed as such.

H. Manufacturer: Corning "MIC" series cables, or equal.

## 2.3 TERMINATION EQUIPMENT

A. Twisted Pair Cabling Patch Panel
1. Refer to Section 27 15 13 for product requirements.

B. Fiber Optic Patch Panels
1. Passive fiber optic physical equipment and apparatus used in interconnecting and cross-connecting fiber optic cables shall possess a minimum fire resistant rating of UL94V-1.
2. The equipment, apparatus, and material for fiber optic equipment an apparatus shall conform to existing OSHA Health and Safety Laws. The equipment and apparatus shall have provision for the application of safety labels such as laser identification or warning labels as required by system considerations.
3. Fiber optic patch panel shall be a fully assembled rack-mounted fiber optic enclosed housing for protecting, storing and organizing the termination of the fiber cable and all fiber strands at each end of the cable. The patch panel shall include an integrated patching facility.
4. "Fully assembled" shall include all required installation & mounting components, and include accessories such as connector panels, coupling adapters, etc. for a complete installation.
5. The fiber patch panel must:
   a. Provide means of strain relief and support of the specified cables.
   b. Contain slack storage facilities for fiber slack.
   c. Provide patch cord management.
6. Manufacturer: Uniprise (by CommScope)
   a. #RFE-FXG-EMT/1U; 1U fiber shelf, accepts 4 adapter plates.
   b. #MFA-SC06-AQ; adapter plate – 6 simplex SC multimode adapters, aqua.
   c. #SFA-SC06-BL; adapter plate – 6 simplex SC singlemode adapters, blue.

## 2.4 FIBER OPTIC CONNECTORS

A. Multimode Fiber Optic Connectors – SC Type
1. Materials:
   a. Ferrule: ceramic (zirconia or alumina) with pre-radiused finish/face.
   b. Connector housing: plastic.
2. Connector shall have an integral strain relief feature, including a bend limiting rear boot.
3. Connectors shall be aqua.
4. Connectors shall be installable via either epoxy or anaerobic method.
5. Manufacturer: Corning Cable Systems, or equal: #95-050-48-BP; SC connector, multimode 50/125.

B. Singlemode Fiber Optic Connectors – SC Type
1. Materials:
   a. Ferrule: ceramic (zirconia or alumina) with pre-radiused finish/face.
   b. Connector housing: plastic.
2. Connector shall have an integral strain relief feature, including a bend limiting rear boot.
3. Connectors shall be blue.
4. Connectors shall be installable via either epoxy or anaerobic method.
5. Manufacturer: Corning Cable Systems, or equal: #95-250-08-BP; SC connector, singlemode.

## 2.5 LABELS

A. Labels for Backbone ISP Cables
1. General: Labels shall be machine printable with a laser printer, ink jet printer, thermal transfer printer, or hand-held printer. Labels shall be adhesive backed and have a self-laminating feature.
2. Printable Area: 2" x 0.5", minimum.

3. Color: White.
4. Manufacturer: Panduit, or equal.
   a. #LJSL7-Y3-1; laser/ink jet labels for cable diameters 0.16"-0.32", white.
   b. #LJSL8-Y3-1; laser/ink jet labels for cable diameters 0.31"-0.69", white.
   c. #LJSL19-Y3-1; laser/ink jet labels for cable diameters 0.31"-1.42", white.

## PART 3 - EXECUTION

### 3.1 GENERAL

A. Comply General Execution requirements of Section 27 00 00.

### 3.2 EXAMINATION

A. Pathways: Prior to installation, verify pathways (cable trays, conduits, etc.) exist and are 'ready' to accept backbone cables.

B. Telecommunications Rooms: Prior to installation, verify equipment rooms are 'ready' to accept the backbone cables and terminations.

### 3.3 PREPARATION

A. The Contractor is solely responsible to verify that twisted pair cables and fiber optic cables are fully operational – both cable sheath and conductors (twisted pair and optical) – prior to installation.

B. Documentation of pre-installation testing is not a close out requirement, and shall be the responsibility of the Contractor.

### 3.4 INSTALLATION – TWISTED PAIR CABLING

A. Backbone Cables
   1. General: Cable runs shall have continuous sheath continuity, homogenous in nature. Splices are not permitted anywhere.
   2. Placement
      a. Maintain a minimum bend radius of 6 times the cable diameter during and after installation.
      b. Maintain pulling tension within manufacturer's limits.
      c. Protect cable during installation. Replace cable if damaged during installation.
      d. Place cables with no kinks, twists, or impact damage to the sheath.
      e. Place a pull rope along with cables where run in conduit and spare capacity still exists in the conduit. Tie off ends of the pull rope.
   3. Routing
      a. Maximum cable length from the termination within the Entrance Facility to the termination in Telecommunications Room shall be 500 meters.
      b. Install cables within designated pathways.
      c. When routing horizontally within telecommunications rooms, utilize the overhead cable support. When routing vertically within telecommunications rooms, utilize the wall mounted vertical cable runway and support every 24 inches on center using cable ties.
      d. Place and suspend cables in a manner to protect them from physical interference or damage.

e. Route cables a minimum of 6" away from power sources to reduce interference from EMI.
f. Provide a 10 feet (minimum) sheathed cable slack loop at each end of the run. Place the slack in the overhead cable support.

4. Termination
a. Properly strain relieve cables at termination points per manufacturer's instructions.
b. Perform terminations in accordance with manufacturer's instructions and TIA/EIA-568-B standard installation practices.
c. Perform post-installation testing as described in the Telecommunication Testing specification.

B. Termination Apparatus
1. Provide accessories required for a complete installation.
2. Terminate twisted pair backbone cables to modular patch panels, terminating one pair to positions 4 and 5.
3. Install the patch panels as shown on the drawing. If not is shown, install patch panels at the top of the rack.

## 3.5 INSTALLATION – FIBER OPTIC CABLING

A. Backbone Cable
1. General
a. Cable runs shall have continuous sheath continuity, homogenous in nature. Splices are not permitted anywhere.
b. Protect fibers during installation & termination. Fibers damaged beyond repair during installation or termination shall result in replacement of the affected cable at no additional cost.
c. Place cables within innerduct the entire route.

2. Placement
a. Bend Radius: Maintain a minimum bend radius of 20 times the cable diameter during installation, and a minimum bend radius of 10 times the cable diameter after installation.
b. Pulling: Maintain pulling tension within manufacturer's limits.
c. Protection: Place and suspend cables in a manner to protect them from physical interference or damage. Replace cable if damaged during installation.
d. Place cables with no kinks, twists, or impact damage to the sheath.
e. Do not use cable-pulling compounds for indoor installations.
f. Provide 30 feet (minimum) sheathed cable slack loop at each end of the run within the Telecommunications Rooms; place the slack in the overhead cable support.
g. Place a pull rope along with cables where run in conduit and spare capacity still exists in the conduit. Tie off ends of the pull rope.

3. Routing
a. Maximum cable length from the termination within the Entrance Facility to the termination in Telecommunications Room shall be 500 meters.
b. Route cables in innerduct between points of termination throughout entire length (except at the fiber take up reel).
c. Install cables within designated pathways.
d. Neatly dress and organize cables using designated cable routing facilities, and fasten to support devices via tie wraps or Velcro-type straps.

e. When routing horizontally within telecom rooms, utilize the overhead cable support. When routing vertically within telecommunications rooms, utilize the wall mounted vertical cable runway and properly fasten. "Properly fasten" shall consist of cable ties in a 'crossed' configuration per cable or cable bundle (up to three cables or innerducts) every 24 inches on center.

f. Place and suspend cables in a manner to protect them from physical interference or damage.

g. Provide a 10 feet (minimum) sheathed cable slack loop at each end of the run. Store slack in slack storage ring mounted on the wall.

4. Termination

a. Properly strain relieve cables at termination points (at/within the fiber optic termination panels) per manufacturer's instructions.

b. Terminate/connectorize fiber strands at both ends using the specified fiber optic connectors appropriate for the mode type of the fiber. Perform terminations in accordance with manufacturer's instructions.

c. Provide required accessories and consumables for the complete termination of fiber strands.

d. Provide 3 feet of tight buffered fiber (unsheathed) slack at each end of the run within the patch panel/termination enclosure. Properly store fiber slack in rear of patch panel into the 'routing rings', per manufacturer's instructions.

B. Fiber Optic Cable Termination Panel

1. Provide the termination panel in designated equipment rack; locate per drawings (if not shown, locate at the top).

2. Provide accessories required for proper installation of each termination panel, including connector panels and adapters.

## 3.6 LABELING

A. General Requirements

1. Labeling and identifier assignment shall conform to the TIA/EIA-606 Administration Standard and as approved by Owner's Representative before installation. Label colors shall conform to the TIA/EIA-606 Administration Standard.

2. Provide permanent and machine-generated labels; hand written labels will not be accepted.

B. Label Formats

1. Cable Labels

a. Text Attributes: Black, 1/8" high, minimum, or #12 font size.

b. Provide labels on both ends of cables. Install labels no more than 4" from the edge of the cable jacket. Fully wrap label around the cable jacket. Install labels such that they are visible by a technician from a normal stance.

2. Termination Apparatus Labels

a. Use labels included in the product packaging. Request approval by the Engineer for substitutions.

b. Provide white label respective field type, per TIA/EIA-606.

c. Text Attributes: Black, 3/32" high, minimum, or #10 font size.

C. Identifier Assignment

1. General: Separate label fields of the identifier with a hyphen.

2. Backbone ISP Twisted Pair Cables
   a. First field shall identify the originating termination room identifier as shown on the plans; for example, "B01-TDA".
   b. Second field shall identify the ending termination room identifier as shown on the plans; for example, "B01-TDB".
   c. Third field of the identifier shall be the campus pair count range; for example, "0401-0600."
   d. Example: "B01-TDA–B01-TDB–0401-0600."
3. Termination Positions at the Patch Panels: Each port shall be labeled with the pair count of the campus infrastructure.
4. Backbone ISP Fiber Optic Cables
   a. First field shall identify the originating termination room identifier as shown on the plans; for example, "B01-TDA".
   b. Second field shall identify the ending termination room identifier as shown on the plans; for example, "B01-TDB".
   c. Third field shall identify the type and number of strands; for example, "Mxxx" where "M" stands for multimode or "S" for singlemode and xxx stands for the ending fiber strand sequential count.
   d. Example: "B01-TDA– B01-TDB–M025-M036."
5. Termination Positions at the Termination Panels
   a. First field of the identifier shall be the destination room; for example "TO B01-TDB".
   b. Second field of the identifier shall be the strand count range; for example, "M025-M036."
   c. Identifier Example:"TO B01-TDB M025-M048."

## 3.7 FINAL INSPECTION

A. Inspect installed products and work in conjunction with the District or District's Representative. Develop a punchlist for items needing correction.

B. Issue punchlist to Engineer for review prior to performing punchlist with the Engineer.

C. Repair defects prior to system acceptance.

D. Inspect installed products and work in conjunction with the Engineer for sign off.

**END OF SECTION**

# SECTION 27 13 14

# TELECOMMUNICATIONS BACKBONE OSP TWISTED PAIR CABLING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section includes: Backbone outside plant (OSP) twisted pair cabling.

B. Related Sections
1. Comply with the Related Sections paragraph of Section 27 00 00.
2. Section 27 05 28 - Telecommunications Building Pathways.
3. Section 27 08 00 - Telecommunications Testing.

C. Products Furnished and Installed Under Another Section: Conduits, pullboxes, and other underground pathways.

### 1.2 REFERENCES

A. Comply with the References requirements of Section 27 00 00.

### 1.3 DEFINITIONS

A. Refer to Division 1 for Definitions.

B. In addition, the following list of terms as used in this specification shall be defined as follows:
1. "BEP": Building Entrance Protection
2. "CMP": Communications Media Plenum
3. "CMR": Communications Media Riser
4. "HDPE": High Density Polyethylene
5. "ISP": Inside Plant
6. "LDPE": Light Density Polyethylene
7. "OSP": Outside Plant
8. "PE": Polyethylene
9. "PIC": Plastic Insulated Conductor
10. "PVC": Polyvinyl Chloride

### 1.4 SYSTEM DESCRIPTION

A. Base Bid Work
1. Base bid work includes engineering, labor, materials, apparatus, tools, equipment, and transportation required to make a complete working telecom backbone twisted pair cabling system installation described in these specifications.
2. Cabling, including terminations at both ends, shown on Drawings shall be considered as base bid work, unless otherwise noted.
3. The Drawings are diagrammatic in nature.
4. In general, the base bid work includes:
   a. Preconstruction Submittals.
   b. Backbone outside plant (interbuilding) twisted pair (copper) cables and terminations.
   c. Building entrance protection and terminals.
   d. Splicing apparatus, as specified.
   e. Cable management.

f. Cable identification tags and system labeling.
g. Record Documents.
h. Warranty.

## 1.5 SUBMITTALS

A. Comply with Division 1 for procedural, quantity, and format requirements.

B. Preconstruction Submittal Requirements:
1. Product Data Submittal, indicating conformance with NEC, UL, TIA/EIA listings, certifications and specifications.
2. Schedule Submittal, consisting of proposed schedule of work.
3. Shop Drawings Submittal, consisting of proposed changes to cable routing, or termination locations/configurations.

C. Closeout Submittal Requirements:
1. As-Built Drawings.
2. O & M Manuals.

## 1.6 QUALITY ASSURANCE

A. Comply with Division 1 Quality Assurance requirements.

B. Contractor Qualifications In addition to the Contractor Qualifications requirements of Division 1, the Contractor shall be manufacturer certified to install the proposed and submitted cabling system and to provide an extended warranty. Provide satisfactory evidence of certification in the form of a current letter or certificate from the manufacturer as part of the bid submission.

## 1.7 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Comply with Division 1 Delivery, Storage and Handling requirements.

## 1.8 WARRANTY

A. The OSP cabling shall be warranted under the minimum Project warranty. Refer to Division 1 for requirements.

# PART 2 - PRODUCTS

## 2.1 UNDERGROUND CABLES

A. Application:
1. Cable shall be suitable for outdoor installations, within underground conduit.
2. Cable shall be twisted pair PIC type cable, filled core, with an "ASP" sheath. Cable shall be compatible with Bell System type "ANMW."

B. Conductors:
1. Conductors shall be 24 AWG annealed solid copper.
2. Conductors shall be fully insulated. Insulation shall consist of an inner layer of expanded PE, covered with an outer layer (skin) of solid PE.
3. Conductors shall be twisted into pairs. Twisted pairs are stranded into 25-pair bundles and into units (and super units, if required by pair count).
4. Color Coding: Twisted pairs and units (supper units, if necessary) shall be individually color coded to industry standards (ANSI/ICEA Publication S-80-576, and EIA-230).

C. Core & Sheath:
1. Cable core (twisted pairs) shall have a tape applied longitudinally (wrapped around it's entirety). Tape Material: non-hydroscopic polypropylene film, or equivalent.
2. Filled: Cable core and sheath shall be flooded with filling compound to protect against moisture penetration. Filling compound: "FLEXGEL", or equivalent.
3. Sheath Type: "ASP". Sheath shall consist of a shield and an outer jacket.
   a. Shield: Dual corrugated tape of inner aluminum and outer steel longitudinally applied, with a locking overlap.
   b. Jacket: PE, bonded to shield.

D. Manufacturers:
1. General "Filled Foam Skin ASP (Spec 2100)" series cables.
2. Belden Communications "Exchange Cable, Filled ASP Cable For Buried Installations" series.
3. Superior Essex "Filled ASP ANMW" series cables.

## 2.2 AERIAL CABLES

A. Application:
1. Cable shall be suitable for outdoor aerial installations.
2. Cable shall be twisted pair PIC type cable, air core, with an "ALPETH" sheath. Cable shall be compatible with Bell System type "BKMA" and RUS type "PE22".

B. Conductors:
1. Conductors shall be 24 AWG annealed solid copper.
2. Conductors shall be fully insulated. Insulation shall consist of solid PE.
3. Conductors shall be twisted into pairs. Twisted pairs are stranded into 25-pair bundles and into units (and super units, if required by pair count).
4. Color Coding: Twisted pairs and units (supper units, if necessary) shall be individually color coded to industry standards (ANSI/ICEA Publication S-80-576, and EIA-230).

C. Core & Sheath:
1. Cable core (twisted pairs) shall have a tape applied longitudinally (wrapped around it's entirety). Tape Material: non-hydroscopic polypropylene film, or equivalent.
2. Sheath Type: "ALPETH". Sheath shall consist of a shield and an outer jacket.
   a. Shield: Corrugated tape of aluminum longitudinally applied, with a locking overlap.
   b. Jacket: PE, bonded to shield.

D. Manufacturers:
1. General "Air Core ALPETH (Spec 2101)" series cables.
2. Belden "Exchange Cable, Alpeth Cable For Aerial Installations" series cables.
3. Superior Essex "SEALPIC" series cables.

## 2.3 SPLICE CLOSURES AND ACCESSORIES

A. Splice Closure – Underground Vault Type
1. Application: Splice closure system shall be suitable for outdoor installation within underground vault and/or maintenance hole.
2. Enclosure:
   a. Enclosure shall be re-enterable.
   b. Through-splice or butt-splice configurations will be accepted.
   c. Size enclosure based on splice bundle diameter and largest incoming cable.

d. End caps shall accept one cable per end / one incoming cable and two outgoing cables.

3. Manufacturer: 3M Telcom, or equal:
   a. #50BA3P-510.
   b. #4460; shield bond connector for cables 100-pair or larger.
   c. #4460-D; shield bond connector for cables 100-pair or smaller.
   d. #25T Ground Braid or #25T Ground Braid with Eyelets.

B. Splice Closure – Building Entrance Type
1. Application: Splice closure system shall be suitable for indoor installation within entrance facilities for splicing between OSP and ISP cable.
2. Closure:
   a. Enclosure shall be re-enterable.
   b. Through-splice or butt-splice configurations will be accepted.
   c. Sleeve shall be solid / Solid or split sleeve will be accepted.
   d. Size enclosure based on splice bundle diameter and largest incoming cable.
   e. End caps shall accept eight single collared or shall have multiple holes.
3. Include all required accessories, such as collars, grommets, bushings, bonding connectors, etc. for a complete installation.
4. Closure system shall be air and water tight. Closure system shall be RUS listed and UL approved.
5. Manufacturer: 3M Telcom, or equal:
   a. #R-3.
   b. #4460; shield bond connector for cables 100-pair or larger.
   c. #4460-D; shield bond connector for cables 100-pair or smaller.
   d. #25T Ground Braid or #25T Ground Braid with Eyelets.

C. Splice Closure – Aerial Type, Straight Splice
1. Application: Splice closure system shall be suitable for outdoor installation in an aerial installation for straight splicing of OSP cables.
2. Manufacturer: 3M Telcom, or equal:
   a. #BA/SES, SliC aerial closure with attached bond assembly, 2" x 19", for up to 100 pair.
   b. #BA/SES, SliC aerial closure with attached bond assembly, 3" x 19", for up to 200 pair.
   c. #BA/SES, SliC aerial closure with attached bond assembly, 3" x 33", for up to 400 pair.

D. Encapsulant
1. Application: Encapsulant shall be suitable for outdoor installation within underground splice closures (vault and/or maintenance hole).
2. Encapsulant shall be re-enterable.
3. Manufacturer: 3M Telcom, or equal: #4442; "High Gel" re-enterable encapsulant.

## 2.4 SPLICE MODULES

A. Splice Module – 710 Dry Straight Type
1. Application: Cable transition (OSP to ISP) in telecom rooms.
2. Modules shall accept mixed solid wire gauges (26 AWG – 19 AWG).
3. Modules shall accept mixed insulation types (PIC, PVC, pulp or paper insulted conductors), up to maximum insulation outside diameter of (.70).
4. Manufacturer: 3M Telcom, or equal: #3M710-SD1-25; 25-pair 710 dry straight splicing module.

B. Splice Module – 710 Filled Straight Type
   1. Application: In-line or branch splicing of OSP cables in underground vaults or manholes.
   2. Modules shall accept mixed solid wire gauges (26 AWG – 19 AWG).
   3. Modules shall accept PIC or PVC insulation.
   4. Modules shall be "preloaded" (filled) with water resistant compound.
   5. Manufacturer: 3M Telcom, or equal: #3M710-SC1-25; 25-pair 710 filled straight splicing module.

## 2.5 BUILDING ENTRANCE PROTECTION

A. General: All BEP terminals shall offer 110-compatible "output" connection type.

B. BEP Terminal – 190 Type
   1. Application: BEP terminal shall be suitable for indoor installation, within a telecom room (such as an Entrance Facility or 'MPOE'). BEP terminals shall provide termination of the backbone twisted pair cables and shall protect premises equipment against induced voltages and stray currents.
   2. Configuration: BEP terminal shall be designed for a wall mounted configuration, shall have the capacity to accept 50 or 100 incoming and outgoing pairs, and shall accept 5-pin type protector modules.
   3. Media Interfaces:
      a. Input shall be 25-foot 26 AWG fusible link stub.
      b. Output shall be 25-foot 24 AWG stub.
   4. Manufacturers:
      a. Porta Systems #26xxx-ST-MST; 190 type BEP terminal, where "xxx" = pair count.
      b. SYSTIMAX #190A1-100 (102 995 099); 100-pair 190 type BEP terminal.
      c. SYSTIMAX #190A1-50 (102 995 073); 50-pair 190 type BEP terminal.

C. BEP Modules – With Sneak Current Protection
   1. BEP modules shall be standard 5-pin type, and be suitable for installation into BEP terminals.
   2. Overvoltage Device: solid state. DC Breakdown Voltage: 220 V. Response time: <100 nsec.
   3. Sneak Current Device: heat coil. Sneak Current: 1 A. Response Time: < 15 sec.
   4. Manufacturers:
      a. Porta Systems #115SCG-250V; solid state module, 220V – 300V breakdown voltage with sneak current protection, black.
      b. SYSTIMAX #4C1S (104 386 545); solid state module, 220V – 300V breakdown voltage with sneak current protection, black.

## 2.6 MISCELLANEOUS MATERIALS

A. OSP Backbone Cable Labels
   1. General: Labels shall be machine printable with a laser printer, ink jet printer, thermal transfer printer, or hand-held printer. Labels shall be adhesive backed and have a self-laminating feature.
   2. Printable Area: 2" x 0.5", minimum.
   3. Color: White.
   4. Manufacturer: Panduit, or approved equivalent.
      a. LJSL7-Y3-1; laser/ink jet labels for cable diameters 0.16"-0.32", white.
      b. LJSL8-Y3-1; laser/ink jet labels for cable diameters 0.31"-0.69", white.
      c. LJSL19-Y3-1; laser/ink jet labels for cable diameters 0.31"-1.42", white.

B. Simplex entry seals for 4-inch conduit
   1. Seal shall create a water-tight seal between the inside of the conduit and the cable. Provide plug sized appropriately.
   2. Manufacturer: Tyco, or equal by Carlon.
      a. #40S136S; for cable OD 1.19-1.36.
      b. #40S196SB; for cable OD 1.38-1.96.
      c. #40S256SB, for cable OD 1.92-2.56.
      d. #40S291SB, for cable OD 2.56-2.91.
      e. #40S327SB, for cable OD 2.91-3.27.

## PART 3 - EXECUTION

### 3.1 GENERAL

A. Comply with Division 1 General Execution requirements.

B. Install products, components, accessories, hardware, etc, according to the manufacturer's instructions.

### 3.2 EXAMINATION

A. Pathways: Prior to installation, verify pathways (underground conduits, etc.) are complete and ready for cables.

B. Equipment Rooms: Prior to installation, verify equipment rooms are complete and ready for cables, splice closures and/or BEP terminals.

### 3.3 PREPARATION

A. Verify cable is fully operational – both cable sheath and conductors – prior to installation.

B. Pre-installation testing as described in the Communication Cable Testing specification, is not required and shall be the responsibility of the Contractor.

### 3.4 INSTALLATION

A. OSP Interbuilding Backbone Cable
   1. Each and every cable run between either termination points or designated splices points shall be a continuous single cable, homogenous in nature. Only splices as noted on the Construction Documents will be permitted.
   2. Placement
      a. Bend Radius: Maintain a minimum bend radius of 6 times the cable diameter during and after installation.
      b. Pulling: Maintain pulling tension within manufacturer's limits. Only use UL approved cable-pulling compounds when necessary to reduce pulling tensions.
      c. Protection: Protect cable during installation. Place and suspend cables in a manner to protect them from physical interference or damage. Replace cable if damaged during installation.
      d. Place cables with no kinks, twists, or impact damage to the sheath.

e. Cables shall be neatly dressed and organized in the cable routing facilities, and fastened to support devices via tie wraps.

3. Routing:
   a. Maintain maximum conductor length of 1,500 meters from the termination at the MDF to the termination in any IDF.
   b. Install cables within designated pathways.
   c. Route cables a minimum of 6" away from power sources to reduce interference from EMI.
   d. When routing vertically within telecom rooms, properly fasten the cable to the cable runway mounted vertically on the wall. "Properly fasten" shall consist of cable ties in a 'crossed' configuration per cable or cable bundle (up to three cables) every 24 inches on center.
   e. When routing horizontally within telecom rooms, utilize the overhead cable tray / cable runway. Route all backbone cables to avoid crossing over horizontal cabling or horizontal cabling crossing backbone cabling.
4. Termination
   a. Provide a 10 foot (minimum) sheathed cable slack loop at each end of the run. Store the slack in the overhead cable tray / cable runway.
   b. Terminate copper pairs at both ends on the specified BEP / termination apparatus.
   c. Properly strain relieve cables at designated points per manufacturer's instructions.
5. Labeling
   a. Provide labels on each end of the cable, no more than 4" from where the cable enters the specified splicing enclosure / termination apparatus.
   b. Place labels such that they are visible by a technician from a normal stance.

B. Underground Splicing Systems
1. Provide underground splice systems either as shown on the Drawings or as shown on shop drawing submittal, including closure, end caps, splice modules, grounding components, and all accessories required for a complete installation. Install splice closure and splice modules per manufacturer's instructions using tools intended for the purpose. Provide re-enterable encapsulant within enclosure.
2. Install closure onto rack system within maintenance hole, as shown on drawings.
3. Grounding and Bonding
   a. Bond cable shield to splice closure bond assembly. Provide bonding conductor from splice closure bond terminal to ground terminal within maintenance hole, if available.
   b. Size bonding conductor 6 AWG up to 25 feet in length; size as 1000 circular mils per foot if longer than 25 feet.
4. Labeling: Provide labels on each splice module and binder group in splice closure.

C. Building Entrance Splicing Systems
1. Provide entrance splice system as shown on the Drawings, including closure, end caps, splice modules, grounding components, and all accessories required for a complete installation. Install splice closure and splice modules per manufacturer's instructions using tools intended for the purpose.
2. Fill unused end cap entry holes with appropriate plug (intended for purpose) for future use.
3. Thoroughly clean and separate all binder groups prior to installing splice modules.

4. Grounding and Bonding
   a. Bond splice enclosure and cable shield to closet busbar using bonding conductor per manufacturer's instructions and/or TIA-607 requirements.
   b. Size bonding conductor 6 AWG up to 25 feet in length; size as 1000 circular mils per foot if longer than 25 feet.
5. Labeling: Provide labels on each splice module and binder group in splice closure.

D. Building Entrance Protection Terminals
1. Provide BEP system as shown on the Drawings, including terminals, modules, and all accessories required for a complete installation. Install BEP per manufacturer's instructions.
2. Install BEP terminals plumb and square, and at height shown on Drawings. If no height is shown, install such that bottom row is at 24" AFF (+/- 3")
3. Provide quantity of protector modules to completely populate terminals
4. Grounding and Bonding
   a. Bond BEP terminal to closet busbar using bonding conductor per manufacturer's instructions and/or TIA-607 requirements.
   b. Size bonding conductor six AWG up to 25 feet in length; size as 1000 circular mils per foot if longer than 25 feet.
5. Labeling
   a. Provide and permanently affix label on the terminal's cover.
   b. Provide label in the label holder at the terminal's "outgoing" connection.

## 3.5 LABELING

A. General Requirements
1. Identifier assignment and scope of labeling shall conform to TIA/EIA-606. Label colors shall conform to TIA/EIA-606.
2. Labels shall be permanent and machine-generated; hand written labels will not be accepted.

B. Label Formats
1. Cable Labels
   a. Text shall black, and shall be 1/8" high, minimum, or number 12 font size.
   b. Install labels no more than 4" from the edge of the cable jacket. Fully wrap label around the cable jacket. Install labels such that they are visible by a technician from a normal stance.
2. BEP Labels – "Output" Connection
   a. Text shall black, and shall be 3/32" high, minimum, or number 10 font size.
   b. Labels shall either be included in the product packaging or shall be fully compatible, in the opinion of the Engineer, with the specified termination apparatus.

C. Identifier Assignment
1. General: Separate all label fields of the identifier with a hyphen.
2. Backbone OSP Twisted Pair Cables
   a. The first field shall identify the beginning and ending pair counts.
   b. The second field shall identify the originating termination room identifier and the destination termination room as shown on the plans.
   c. Identifier Example:"0001-0200 B01-TDA–B02-TDA."
3. BEP Terminal Cover
   a. The first field of the identifier shall be the pair count; e.g., "0001-0200."

b. The second field of the identifier shall be cable's other end room; e.g., "FROM B01-TDA".

## 3.6 INSPECTION AND ADJUSTMENTS

A. Inspect installed products and completed work in conjunction with the Owner, or Owner's Representative. Develop a punchlist for items needing correction.

B. Provide punchlist to Owner, or Owner's Representative. For review prior to performing punchlist with the Engineer.

C. Repair defects prior to system acceptance.

D. Inspect installed products and work in conjunction with the Owner, or Owner's Representative. for sign off.

## 3.7 DEMONSTRATION

A. On completion of the acceptance test, schedule a time convenient with the Owner, or Owner's Representative, for instruction in the layout and maintenance of the system.

## 3.8 CERTIFICATION

A. Provide the Owner, or Owner's Representative, with a written form of acceptance for signature.

**END OF SECTION**

# SECTION 27 15 13

# TELECOMMUNICATIONS HORIZONTAL CABLING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes: Horizontal Cabling (subsystem of Telecommunications Cabling Infrastructure).

B. Related Sections
1. Comply with the Related Sections paragraph of Section 27 00 00.
2. Section 27 05 28 - Telecommunications Building Pathways.

C. Products Furnished and Installed Under Another Section:
1. Conduits, sleeves, and other pathway systems for building distribution.
2. Conduit stubs and device (back) boxes for devices/outlets.
3. Surface raceway – base, cover, and device plates.

### 1.2 REFERENCES

A. Comply with the References requirements of Section 27 00 00.

### 1.3 DEFINITIONS

A. Refer to Section 27 00 00 for Definitions.

B. In addition, the following list of terms as used in this specification shall be defined as follows:
1. "CAT6": Category 6.
2. "Channel": End to end transmission path; e.g., the entire portion of the horizontal cabling to each outlet consisting of the Permanent Link, line cord (at the workstation), patch cord, and, if a full cross-connection is implemented, the cross-connect termination/connecting apparatus and equipment cord.
3. "CMP": Communications Media Plenum, plenum rating; synonymous with "MPP."
4. "CMR": Communications Media Riser, riser rating; synonymous with "MPR."
5. "FEP": Fluorinated Ethylene Propylene.
6. "Permanent Link": Test configuration for a horizontal cabling link excluding test cords, connections at the ends of the test cords, patch cords, equipment cords, line cords; e.g., the 'permanent' portion of the horizontal cabling to each outlet consisting of cable, consolidation point (if used), termination/connecting apparatus in the Telecommunications Room and the connector at the outlet.
7. "PVC": PolyVinyl Chloride.
8. "UTP": Unshielded Twisted Pair.

### 1.4 SYSTEM DESCRIPTION

A. Base Bid Work
1. Provide engineering, labor, materials, apparatus, tools, equipment, and transportation required to make a complete working telecommunications Horizontal Cabling System installation described in these specifications.
2. Consider horizontal cabling as shown on Drawings to be base bid work, unless otherwise noted.

B. In general, the base bid work includes:
   1. Preconstruction Submittals.
   2. Horizontal cables, terminations, and outlets.
   3. Cable management.
   4. Patch cords and cross-connects.
   5. Cable identification tags and system labeling.
   6. Record Documents.
   7. Warranty.

## 1.5 SUBMITTALS

A. Comply with the Submittals article of Section 27 00 00 for procedural, quantity, and format requirements.

B. Preconstruction Submittal Requirements:
   1. Product Data Submittal, indicating conformance with NEC, UL, TIA/EIA listings, certifications and specifications.
   2. Shop Drawings Submittal, consisting of proposed changes to cable routing, or termination locations/configurations.
   3. Typical Outlet Sample, including faceplate, faceplate label, connectors/jacks, port labels, cables (about 12" sample), and cable label.

C. Closeout Submittal Requirements:
   1. As-Built Drawings.
   2. Cross-connection records/cut sheets.
   3. O & M Manuals.

## 1.6 QUALITY ASSURANCE

A. Comply with the Quality Assurance requirements of Section 27 00 00.

B. Contractor Qualifications
   1. In addition to the Contractor Qualifications requirements of Section 27 00 00, the Telecommunications Installer shall be a Panduit Certified Installer (PCI), certified by Panduit Corporation, and shall be capable of providing an extended warranty in the CertificationPlus system warranty program.
   2. Provide evidence in the bid submission of certification in the PCI program. Evidence shall consist of a "Certification Of Participation" issued by Panduit Corp listing the Telecommunications Installer's company name.

## 1.7 DELIVERY, STORAGE AND HANDLING

A. Comply with the Delivery, Storage and Handling requirements of Section 27 00 00.

## 1.8 WARRANTY

A. The telecommunications horizontal cabling system, as specified in this section, shall receive a CertificationPlus system warranty. This extended warranty shall cover parts and labor for the duration of the extended warranty. This extended warranty shall also cover electrical performance of cabling system to the specific category per ANSI/TIA/EIA-568-B performance criteria for Permanent Link.

## PART 2 - PRODUCTS

### 2.1 SUBSTITUTIONS

A. Comply with the Substitutions requirements of Section 27 00 00.

### 2.2 HORIZONTAL CABLE

A. Application: Suitable for indoor installation.

B. Conductors:
1. Insulated Conductors: 23 AWG solid-copper fully-insulated with a flame retardant thermoplastic material (material = PVC, or equivalent).
2. Twisted Pairs: Two insulated conductors twisted to form a pair (twisted pair), and individually color-coded to industry standards (ANSI/ICEA Publication S-80-576-1994, and EIA-230).

C. Cable Sheath:
1. The cable shall be unshielded.
2. Outer jacket shall be seamless (material = LS-PVC, or similar) applied to and completely covering the internal components (four twisted pairs).
3. Flame Rating: NEC (Article 800) rated as CMP, and UL listed as such.
4. Cable sheath shall be round.

D. Electrical Performance: Meet or exceed TIA/EIA-568-B.2-1 and ISO/IEC 11801 requirements for CAT6 UTP cabling.

E. Packaging: Cable shall come as 1,000 foot put-ups packaged in a box.

F. Manufacturer: Panduit, or equal by Berk-Tek, General Cable, SYSTIMAX, CommScope, or Belden:
1. #PUP6004BU-U, "TX6000" CAT6 UTP CMP, Blue.
2. #PUP6004GY-U, "TX6000" CAT6 UTP CMP, Gray.

### 2.3 MODULAR PATCH CORDS

A. Application: Suitable for indoor installation within a telecommunications room or workstation environment. Cords shall be assembled from a single, continuous length of cordage, homogenous in nature, and shall be terminated at both ends via 8 position modular plugs. Splices are not permitted anywhere.

B. Cordage
1. Insulated Conductors: 24 AWG stranded copper, fully insulated with a flame retardant thermoplastic material (such as PVC, or equivalent).
2. Twisted Pairs: Two insulated conductors "twisted" into a "pair" (twisted pair), and individually color-coded.
3. Sheath shall be unshielded, flame-retardant polyvinyl chloride (PVC) jacketed.
4. Flame Rating: NEC CM (or higher) rated and UL listed as such.

C. Electrical Performance: Comply with TIA/EIA 568-B for CAT6 UTP patch cords and Channel requirements (minimum).

D. Manufacturer: Panduit #UTPSPx ("x" varies for length).

## 2.4 CROSSCONNECT WIRE

A. Application: Suitable for indoor installation within a 110-based crossconnect system. Each and every crossconnect wire shall be manufactured from a single, continuous length of insulated wire, homogenous in nature. Splices are not permitted anywhere.

B. Factory splices of insulated conductors are expressly prohibited.

C. Conductors:
1. Insulated Conductors: Conductors shall be 24 AWG solid copper. Conductors shall be fully insulated with a flame retardant thermoplastic material (such as PVC, or equivalent).
2. Twisted Pairs: Two insulated conductors shall be "twisted" into a "pair" (twisted pair). Twisted pairs shall be individually color coded.

D. Manufacturer: General, or equal:
1. #7041973; crossconnect wire, 1 pair, Whi-Red / Red-Whi.
2. #7042047; crossconnect wire, 1 pair, Whi-Blu / Blu-Whi.

## 2.5 PATCH PANEL

A. Application: Patch panel shall be suitable for installation within a telecommunication room for the termination of the CAT6 UTP 4-Pair Cable (specified herein), and shall be horizontally oriented for a rack-mounted configuration.

B. Patch panel shall have discrete ports, fully compatible with the connectors / modular jacks – refer to this section for connectors.

C. Patch panels shall be capable of supporting, organizing, labeling and patching/crossconnecting between the horizontal termination field and the equipment and/or the equipment termination field.

D. Manufacturer: Panduit #CPPL24M6BL; 24-port discrete patch panel – less connectors/modular jacks.

## 2.6 WORKSTATION OUTLETS

A. Faceplate for Flush Mount Outlets
1. Refer to outlet schedule in the Drawings for port quantity per outlet type.
2. Faceplate shall include required accessories, such as icons, blank inserts, and labels. Faceplate shall be by the same manufacturer as the connectors.
3. Faceplate shall be "Executive" series, "IE" color.
4. Manufacturer: Panduit:
   a. #CFPE2IE; Mini-Com line Executive series faceplate, 2-port.
   b. #CFPE4IE; Mini-Com line Executive series faceplate, 4-port.

B. Faceplate for Wall Phone Outlets:
1. Faceplate for wall phone outlets shall come equipped with 1 modular jack and two mounting studs.
2. Manufacturer: Panduit #KWP6PY; Faceplate for wall phone, with modular jack.

C. Faceplate for Open Office Furniture Outlets:
1. Application: Faceplate shall be compatible with the baseplate and beltway of the selected open office furniture, and shall "snap" into the furniture opening.
2. Faceplate shall have 4 ports.

3. Manufacturer (example – confirm open office system): Panduit #CFFPL4BL; snap-on faceplate for open office furniture, 4-port.

D. Adapters for Raceway Mount Outlets
1. Application: Adapter / module insert shall be compatible with the surface raceway opening designated for telecom use. Refer to the Outlet Schedule of the Drawings for additional information. Refer to the electrical drawings for raceway information.
2. Manufacturer: Panduit #CH02MEI-X; module insert for raceway.
3. Color shall match electrical device and/or coverplate.

E. Adapters for Poke-Thru Devices
1. Application: Adapter / module insert shall be compatible with the poke-thru device. Refer to the Outlet Schedule of the Drawings for additional information. Refer to the electrical Drawings and Specifications for poke-thru device information.
2. Manufacturer: Panduit #CH02MEI-X; module insert for Wiremold "Open Systems" devices.
3. Color shall match electrical device and/or coverplate.

## 2.7 CONNECTORS / MODULAR JACKS

A. Connectors shall be 8-position 8-conductor modular type, shall be CAT6 rated, and shall be intended for the termination of 4-pair UTP cables. Connectors shall be by the same manufacturer as the faceplates.

B. Connectors shall be T568B wired.

C. Manufacturer: Panduit #CJ688TGOR; Mini-Com TX6 Plus Jack Module, Orange.

## 2.8 COURTESY/CAMPUS PHONE

A. Indoor, wall-mount type: Allen Tel #GB306V.

## 2.9 WIRELESS LAN ACCESS POINT ENCLOSURE

A. Indoor ceiling-mount type: Oberon #1055.

B. Indoor wall-mount type: Oberon #1023-00.

## 2.10 LABELS

A. Labels shall be machine printable with a laser printer, ink jet printer, thermal transfer printer, or hand-held printer.

B. Horizontal Cable Labels
1. Labels shall be adhesive backed and have a self-laminating feature.
2. Labels shall wrap around the cable's jacket.
3. Printable Area: size: 2" x 0.5", minimum; color: white.
4. Manufacturer, or equal: Panduit: #LJSL7-Y3-1; laser/ink jet labels for cable diameters 0.16"-0.32", white.

C. Outlet Faceplate and Port Labels
1. Labels shall be adhesive backed.
2. Port labels shall fit above the port without overlap to the next port or to the port itself.

3. Manufacturer, or equal: Panduit.
   a. #C125X030FJJ; "Equipment Room Identifier" label, for laser printer.
   b. #C061X030FJJ; "Unique Cable Number" label, for laser printer.

D. Modular Patch Panels
1. Labels shall be adhesive backed.
2. Labels shall fit above the port without overlap to the next port or to the port itself.
3. Printable Area: size: 0.61" x 0.33", minimum; color: white.
4. Manufacturer, or equal: Panduit. #CPPLF-5; laser labels for modular patch panels, white.

E. 110 Termination Block Labels
1. Color: Blue for horizontal termination field.
2. Manufacturer, or equal: Panduit #DSL110-BU; label inserts, blue.

## 2.11 MISCELLANEOUS COMPONENTS

A. Velcro Cable Ties
1. Width: .75".
2. Color: Velcro cable ties shall be the same color as the cable to which it is being applied.
3. Manufacturer, or equal: Panduit #HLS-15R-0 Black, 15' roll, cut to length.

# PART 3 - EXECUTION

## 3.1 GENERAL

A. Comply with the Execution requirements of Section 27 00 00.

B. Install products, components, accessories, hardware, etc, according to the manufacturer's instructions.

## 3.2 EXAMINATION

A. Pathways: Prior to installation, verify pathways are complete and ready for cables.

B. Equipment Rooms: Prior to installation, verify equipment rooms are complete and ready for cables.

## 3.3 INSTALLATION

A. Horizontal Cable
1. General:
   a. Cable runs shall have continuous sheath continuity, homogenous in nature. Splices are not permitted anywhere.
   b. Maintain maximum cable length of 90 meters from the termination in the Telecommunications Room to the termination at the outlet.
   c. A cable bundle shall contain no more than 24 individual cables.
2. Color:
   a. Provide Blue cables for data links.
   b. Provide Gray cables for voice-only links.
3. Installation:
   a. Maintain a minimum bend radius of 6 times the cable diameter during and after installation.
   b. Maintain pulling tension within manufacturer's limits.

c. Protect cable during installation. Replace cable if damaged during installation.
d. Place cables with no kinks, twists, or impact damage to the sheath.
e. Place and suspend cables in a manner to protect them from physical interference or damage.

4. Routing
   a. When routing horizontally within Telecommunications Room, utilize the overhead cable support. When routing vertically within Telecommunications Room, fasten the cable bundles using approved cable ties to the wall-mounted vertical cable support every 24 inches on center.
   b. Route cables a minimum of 6" away from power sources to reduce interference from EMI.
   c. When routing cables in areas without primary horizontal pathways, install cables onto secondary pathways or approved support devices, such as cable hangers.
   d. Route cables at 90-degree angles, allowing for bending radius along corridors for ease of access. Do not route through an adjacent space if a corridor borders at least one wall of the room.
   e. Provide a 10 feet (minimum) sheathed cable slack loop at each end of the run. In the Telecommunications Room, place the slack in the overhead cable support. At the workstation, place cable in ceiling space before the device conduit stub supported from a cable hanger.
   f. Provide six inches (minimum) of sheathed cable slack behind each workstation outlet faceplate. The slack cable shall be coiled inside the device box, the surface raceway, or within the wall, in accordance with the cabling manufacturer's installation standards.
   g. At the equipment bay in the Telecommunications Room where floor-standing racks are used, divide horizontal cables equally between both sides of an equipment rack such that a cable does not travel past the midpoint of the rack prior to termination. At the equipment bay in the Telecommunications Room where wall-mounted racks are used, route the horizontal cables down the hinged side of the equipment rack.

5. Termination
   a. Properly (per manufacturer's instructions and TIA/EIA-568-B standard installation practices) strain relieve cables at termination points.
   b. Terminate pairs on the specified connecting hardware. Perform terminations in accordance with manufacturer's instructions and TIA/EIA-568-B standard installation practices.

B. Patch Panels and Horizontal Management Panels
1. Provide discrete patch panels in a quantity to allow termination of data cables served from respective IDF.
2. Install the discrete patch panels and horizontal management panels in the configuration as shown on the Drawings. Install panels level.

C. Outlet Faceplates
1. Install faceplates plumb, square, and at the same level as adjacent device faceplates.
2. Patch gaps around faceplates so that faceplate covers the entire opening.
3. For surface raceway, color shall match electrical device and/or coverplate.

D. Outlet Modular Connectors
1. Terminate pairs on the specified modular connector. Perform terminations in accordance with manufacturer's instructions and TIA/EIA-568-B standard installation practices.
2. Replace terminations and connectors not passing the required media test.

E. Courtesy/ Campus Telephone
1. Provide backing plate.
2. Install phone unit to height noted in Drawings and per manufacturer's instructions, and in compliance with codes.
3. Obtain extension number from ITS.
4. Provide permanent label on phone unit that displays the telephone's extension.

F. Wireless LAN Access Point Enclosures: Refer to Drawings for enclosure cabling service and installation requirements.

G. Cords and Crossconnects
1. Refer to Telecommunications Outlet Schedule of the Drawings for cord (workstation, Telecom Room, and other) patching and crossconnecting requirements.
2. Splices in patch cords and crossconnect wire are prohibited.
3. Record crossconnections in IDFs for MDF crossconnection purposes and for record documents.
4. Color:
   a. For digital handsets, provide: White-Blue / Blue-White.
   b. For analog handsets, provide: White-Red / Red-White.

## 3.4 LABELING

A. General Requirements
1. Labeling, identifier assignment, and label colors shall conform to TIA/EIA-606-A Administration Standard and as approved by Owner's Representative before installation.
2. Labels shall be permanent with machine-generated text; hand-written labels will not be accepted.

B. Label Formats
1. Horizontal Cable Labels
   a. Text Attributes:
      1) Black.
      2) 1/8" high, minimum, or #12 font size.
      3) Font: Verdana preferred, or SansSerif or Arial acceptable.
   b. Install labels on both ends of cables no more than 4" from the edge of the cable jacket. Install labels such that they are visible by a technician from a normal stance.
2. Modular Patch Panel Labels
   a. Use modular patch panel labels included in the product packaging. (Approval by the Owner shall be required for other labels.)
   b. Use a label color for the respective field type, per TIA/EIA-606.
   c. Text Attributes: Black, 3/32" high, minimum, or #10 font size.
3. Outlet Labels
   a. Text Attributes: Black, 1/8" high, minimum, or #12 font size.
   b. Provide an "Equipment Room Identifier" label at the top of the faceplate with the serving telecommunication room's identifier (refer to 27 11 00 for telecommunication room identifier assignment).
   c. Provide a "Unique Cable Number" label above each port with the link's unique cable number.

C. Identifier Assignment
   1. Horizontal Cables / Cabling Link: Assign each cable a unique number, in ascending order beginning with the number 1.
   2. Outlet Ports: The outlet ports shall be identical to the unique cable number.
   3. Modular Patch Panel Ports: The modular patch panel ports shall be identical to the unique cable number.

## 3.5 FINAL INSPECTION

A. Inspect installed products and work in conjunction with the Owner. Develop a punchlist for items needing correction.

B. Issue punchlist to the Owner for review prior to performing punchlist walk.

C. Repair defects prior to system acceptance.

D. Inspect installed products and work in conjunction with the Owner for sign off.

**END OF SECTION**

SECTION 27 51 13

# Event Annunciation System – Building Distribution

## PART 1 - GENERAL

### 1.01 SUMMARY

A. Section Includes: event annunciation system's building distribution (subsystem of the EAS).

B. Related Sections

1. Comply with the Related Sections paragraph of Section 27 00 00.

### 1.02 REFENCES

A. Comply with the References requirements of Section 27 00 00.

### 1.03 DEFINITIONS

A. Refer to Section 27 00 00 for Definitions.

B. In addition, the following list of terms as used in this specification shall be defined as follows:

1. "EAS": Event Annunciation System
2. "CL2P": Class 2 Power Listed Circuit Plenum, plenum rating
3. "CMP": Communications Media Plenum, plenum rating; synonymous with "MPP"

### 1.04 SYSTEM DESCRIPTION

A. Other System Elements

1. SMCCCD intends to use the existing carillon systems at Cañada College as the EAS headend.
2. SMCCCD will provide amplifiers per building in the TDx rooms, where the loudspeaker wiring originates.

B. Base Bid Work

1. Provide engineering, labor, materials, apparatus, tools, equipment, and transportation required to complete the building distribution segment of the District's event annunciation system throughout designated spaces within campus buildings, and as described in these specifications.
2. Consider wiring/cabling and loudspeakers to be base bid work, unless otherwise noted. Amplifiers shall not be base bid work.

C. Loudspeaker Criteria

1. Selection Guidelines: The following list offers guidelines for selecting the appropriate loudspeaker type per instance to be noted on shop drawings for approval by the District.
   a. For indoor spaces with lay-in tile suspended ceilings (such as corridors), provide indoor ceiling-mount type loudspeaker.
   b. For indoor spaces with no ceilings (such as stairwells, lobbies, and corridors with no ceilings), provide indoor wall-mount type loudspeaker.

2. Placement Guidelines: The following list offers guidelines for the installer to locate loudspeakers on shop drawings for approval by the District.
   a. In public corridors, equal to or less than 10 feet wide and 10 feet high, provide loudspeakers spaced approximately 30 feet apart. Attempt to locate loudspeakers near exits and elevators.
   b. In stairwells of three stories or less, provide at least one loudspeaker per stairwell located on the middle landing. In stairwells of greater than three stories, provide at least one speaker on every other floor.
   c. Do not provide loudspeakers in small/medium classrooms (lecture, lab, etc.), meeting rooms, lounges, offices, or other occupied rooms with less than 125 person occupancy. Classrooms with greater than 125 occupancy should get one speaker over the teaching station.

D. In general, the base bid work includes:
   1. Preconstruction Submittals
   2. Cabling/Wiring
   3. Supplemental pathway devices and cable management
   4. Loudspeakers
   5. Cable identification tags and system labeling
   6. Record Documents
   7. Warranty

## 1.05 SUBMITTALS

A. Comply with the Submittals article of Section 27 00 00 for procedural, quantity, and format requirements.

B. Preconstruction Submittal Requirements:
   1. Product Data Submittal, indicating conformance with NEC, UL listings, certifications and specifications
   2. Shop Drawings Submittal, consisting of proposed loudspeaker locations and cable routing

C. Closeout Submittal Requirements:
   1. As-Built Drawings

## 1.06 QUALITY ASSURANCE

A. Comply with the Quality Assurance requirements of Section 27 00 00.

## 1.07 DELIVERY, STORAGE, AND HANDLING

A. Comply with the Delivery, Storage and Handling requirements of Section 27 00 00.

## 1.08 WARRANTY

A. Warrant wiring/cabling and loudspeakers for a period of 2 years. Warranty period shall begin upon SMCCCD's written acceptance of system installation.

## PART 2 - PRODUCTS

### 2.01 SUBSTITUTIONS

A. Comply with the Substitutions requirements of Section 27 00 00.

### 2.02 AUDIO CABLE

A. Application: Suitable for indoor installation within closed ceiling space or open corridors.

B. Wires: Wires shall be 14 AWG stranded copper, fully-insulated with a flame retardant thermoplastic material (PVC, or equivalent), and individually color-coded

C. Shield: The cable shall have one foil/tape shield fully covering the wires.

D. Outer Jacket: The cable shall be sheathed with a seamless thermoplastic (LS-PVC, or similar) jacket applied to and completely covering the internal components (wires and shield).

E. Flame Rating: NEC (Article 725) rated as CL2P or NEC (Article 800) rated as CMP, and UL listed as such.

F. Manufacturer: Belden #6100FE, or equal

### 2.03 LOUDSPEAKER – INDOOR CEILING-MOUNT TYPE

A. Suitable for indoor installation within closed ceiling space into corridors.

B. Finish shall be flush with ceiling tile, including trim ring

C. Manufacturer:

1. Bogen #HFCS1LP, enclosed ceiling-mount loudspeaker
2. Bogen #TBCR, tile bridge support ring
3. Bogen #CK10, safety cable kit

### 2.04 LOUDSPEAKER – INDOOR WALL-MOUNT TYPE

A. Suitable for indoor wall-mount installations, such as stairwells and/or corridors with no ceilings.

B. Manufacturer: Bogen #MB8TSLVR

### 2.05 LOUDSPEAKER – OUTDOOR SURFACE-MOUNT TYPE

A. Suitable for outdoor installation for open spaces

B. Loudspeaker shall be horn type

C. Manufacturer: Bogen #KFLDS30T

### 2.06 LABELS

A. Labels shall be machine printable with a laser printer, ink jet printer, thermal transfer printer, or hand-held printer.

B. Cable Labels

1. Labels shall be adhesive backed and have a self-laminating feature.
2. Labels shall wrap around the cable's jacket.
3. Printable Area: size: 2" x 0.5", minimum; color: white.
4. Manufacturer: Panduit #LJSL7-Y3-1, or equal

## 2.07 MISCELLANEOUS MATERIALS

A. Cable Hangers

1. Application: Suitable for indoor installation within ceiling space for the support of cables.
2. Listings: UL 2043, for use in air handling spaces
3. Manufacturers (or variation per installation method): B-Line #BCH12-W2, or equal

B. Velcro Cable Ties

1. Width: .75".
2. Color: Velcro cable ties shall be the same color as the cable to which it is being applied.
3. Manufacturer, or equal: Panduit
   a. #HLS-15R-0 Black, 15' roll, cut to length.

# PART 3 - EXECUTION

## 3.01 GENERAL

A. Comply with the Execution requirements of Section 27 00 00.

B. Install products, components, accessories, hardware, etc, according to local, state, and federal codes, and per the manufacturer's instructions.

## 3.02 EXAMINATION

A. Pathways: Prior to installation, verify route and capacity of existing pathways, and ready for new cables.

## 3.03 INSTALLATION

A. Loudspeaker – Indoor Ceiling-Mount Instances

1. Cut ceiling tile such that no visible cuts and/or openings are visible after installation of loudspeaker and trim.
2. Provide one bridge support ring per loudspeaker spanning the "T-bar" of the suspended ceiling system.
3. Provide one safety cable per loudspeaker attached to building structure for seismic bracing. Provide accessories, such as power-actuated masonry fasteners, to attach safety cable to structure.
   a. Obtain written approval from SMCCCD of fastening component prior to installation.

B. Loudspeaker – Indoor Wall-Mount Instances

1. Coordinate the loudspeaker's installation location with cable route to minimize the route of surface-mounted raceway and cable (minimize the length of 'exposed' raceway and cable).

2. Locate loudspeaker at least 8 feet 6 inches above finished floor in public spaces such as corridors. Locate loudspeakers at lease 6 inches from nearest obstruction (soffit, duct, etc.).
3. No loudspeaker shall block visibility to an exit sign. The Contractor shall relocate loudspeakers at SMCCCD's discretion should the installed conditions potentially violate code.
4. Attach loudspeaker to surface using fasteners appropriate for the substrate; for example, provide masonry fasteners (screws such as Tap-Con) for concrete walls.

C. Pathways

1. Utilize existing pathways to the maximum possible extent.
2. Where necessary, provide supplemental pathways devices such as cable hangers.
3. Where cables route on exposed walls, provide metallic surface raceway. Attach raceway to surface using fasteners appropriate for the substrate; for example, provide masonry screws for concrete walls.

D. Loudspeaker Cable

1. General
   a. Cable runs shall have continuous sheath continuity, homogenous in nature. Splices are not permitted anywhere.
   b. Provide at least one cable run per floor. If the building's layout/floor plan will not allow a single run per floor in a logical manner, then provide two runs on that floor(s).
   c. Connect the audio cable to the loudspeakers in a parallel wiring configuration.
2. Installation
   a. Maintain a minimum bend radius of 6 times the cable diameter during and after installation.
   b. Maintain pulling tension within manufacturer's limits.
   c. Protect cable during installation. Replace cable if damaged during installation.
   d. Place cables with no kinks, twists, or impact damage to the sheath.
   e. Place and suspend cables in a manner to protect them from physical interference or damage.
   f. Place cables onto/into pathways or approved support devices, such as cable hangers. Do not strap and/or cable tie cables to the outside of existing pathways (which is a code violation) and to ceiling support wires.
3. Routing
   a. Route cables a minimum of 6" away from power sources to reduce interference from EMI.
   b. Route cables at 90-degree angles, allowing for bending radius along corridors for ease of access. Do not route through an adjacent space if a corridor borders at least one wall of the room.
   c. Within Telecommunications Rooms:
      1) Routing horizontally, utilize the overhead cable support.
      2) Routing vertically, fasten the cable bundles using approved cable ties to the wall-mounted vertical cable support every 24 inches on center.
   d. Provide a 10 feet (minimum) sheathed cable slack loop at the telecommunication room end of the run (for future termination).

## 3.04 LABELING

A. Labels shall be permanent with machine-generated text; hand-written labels will not be accepted.

B. Text Attributes:

1. Black,

2. 1/8” high, minimum, or #12 font size.
3. Font: Verdana preferred; SansSerif or Arial acceptable.

C. Install labels on both ends of cables no more than 4" from the edge of the cable jacket. Install labels such that they are visible by a technician from a normal stance.

D. Label Content: Labels shall display the building and floor, and (if applicable) the run number.

## 3.05 FINAL INSPECTION

A. Inspect installed products and work in conjunction with SMCCCD. Develop a punch list for items needing correction.

B. Issue punch list to the SMCCCD for review prior to SMCCCD performing their punch walk.

C. Repair defects prior to system acceptance.

D. Inspect installed products and work in conjunction with SMCCCD for sign off.

END OF SECTION

# SECTION 27 53 13

# CENTRAL CLOCK SYSTEM

## PART 1 - GENERAL

### 1.01 SUMMARY

A. General: The district utilizes a Simplex central clock system that provides synchronized timepieces throughout its three colleges and the district administration building. Provide, labor, materials, apparatus, tools, equipment, transportation, temporary construction and special or occasional services as required to complete a working Central Clock system installation, as described in these specifications.

B. Section Includes:

1. Secondary field clocks (Simplex #6310-9231) capable of connecting to a SIMPLEX 6351 Master Clock System
2. Secondary clock cable requirements

C. Products Specified But Not Installed Under This Section:
1. Secondary clock single gang back boxes with ¾" conduit to accessible ceiling space

D. Related Sections:
1. Comply with related section paragraphs of section 27 00 00 Telecommunications Basic Requirements.
2. Comply with related section paragraphs of section 27 13 10 Telecommunications backbone ISP cabling.
3. Comply with related section paragraphs of section 27 13 14 Telecommunications backbone OSP cabling.
4. Comply with related section paragraphs of section 27 15 13 Telecommunications horizontal cabling.
5. Comply with related section paragraphs of section 26 01 00 Basic materials and methods.

### 1.02 SYSTEM DESCRIPTION

A. Overview
1. Central clock system (existing) will provide a centrally located clock controller to maintain accurate time and adjustment to secondary clocks (new) located in classrooms, offices and administration areas throughout the campus distribution system.

### 1.03 SUBMITTALS

A. Contractor Qualifications: Submit certification letters for District clock manufacturer "Simplex".

B. Product Data: Submit product information for components specified herein. Refer to Section 28 00 00 for format and requirements.

C. Shop Drawings: Submit shop drawings in accordance with Division 1. Refer to Section 28 00 00 for format and requirements.

## PART 2 - PRODUCTS

### 2.01 MANUFACTURERS

A. Secondary Clocks: Use Simplex model 6310-9231 for secondary surface mounted clocks or equal.

1. 12” diameter round black frame.

2. Black Arabic numerals.

3. Use a continuous sweeping second hand.

4. Surface mounted on the wall.

## PART 3 - EXECUTION

### 3.01 INSTALLATION

A. Secondary Field Clocks
1. Provide single gang back box with ¾” conduit to accessible ceiling space at 96” AFF (provided by electrical contractor).

2. Route connection cable to single gang back box.

3. Install clock making connection to cable in single gang back box.

**END OF SECTION**

# SECTION 28 00 00

# BASIC SECURITY SYSTEM REQUIREMENTS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. This Section includes general administrative and procedural requirements for Sections numbering 28xxxx, and is intended to supplement, not supersede, the requirements specified in Division 1.

B. Related Sections
1. General: 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 and operable system.
2. Related Sections:
   a. Section 078400: Firestopping.
   b. Section 087100: Door Hardware.
   c. Section 081000: Doors and Frames.
   d. Section 281300: Access Control & Alarm Monitoring System.
   e. Section 282300: Video Surveillance System.
   f. Section 280513: Security System Cabling.
   g. Section 280553: Security System Labeling.
   h. Section 280800: Security System Commissioning.
   i. Section 142400: Hydraulic Elevators.
   j. Section 260529: Hangers and Supports for Electrical Systems.
   k. Section 260533: Raceway and Boxes for Electrical Systems.
   l. Section 210900: Instrumentation and Control for Fire-Suppression Systems.
3. General and Supplementary Conditions: Drawings and general provisions of Contract and Division 1 of the Specifications, apply to 28xxxx series Sections.

### 1.2 REFERENCES

A. Reference to codes, standards, specifications and recommendations of technical societies, trade organizations and governmental agencies shall mean that latest edition of such publications adopted and published prior to submittal of the bid. Consider such codes or standards a part of this Specification as though fully repeated herein.

B. Codes: Perform work in accordance with all applicable requirements of the latest edition of all governing codes, rules and regulations including but not limited to the following minimum standards, whether statutory or not:
1. National Electric Code (NEC), NFPA 70.
2. California Code of Regulations (CCR) Title 24, California Building Standards Code Part 2, Basic Building Regulations and Part 3, California Electrical Code (CEC).
3. Uniform Building Code (UBC).
4. Uniform Fire Code (UFC).
5. Uniform Mechanical Code (UMC).
6. National, State, Local and any other binding building and fire codes.
7. FCC Regulations: Part 15 – Radio Frequency Devices & Radiation Limits.
8. Underwriter's Laboratories (UL): Applicable listing and ratings.
   a. UL 294:Access Control System Units.
   b. UL 1076:Proprietary Burglar Alarm Units and Systems.
9. EIA testing standards.

C. Make a copy of each document readily available during the course of construction for reference by field personnel.

## 1.3 DEFINITIONS

A. The Definitions of Division 1 shall apply to the 28 00 00 sections.

B. In addition to those Definitions of Division 1, the following list of terms as used in this specification shall be defined as follows:
1. "Furnish": To purchase, procure, acquire, and deliver complete with related accessories.
2. "Install": To set in place, join, unite, fasten, link, attach, set up or otherwise connect together and test before turning over to the University, all parts, items, or equipment supplied by contractor. Installation shall be complete and ready for regular operation.
3. "Provide": To furnish, transport, install, erect, connect, test and turn over to the Owner, complete and ready for regular operation.
4. "Connect": To install all required patch cords, equipment cords, cross-connect wire, etc. to complete an electrical or optical circuit.
5. "As directed": As directed or instructed by the Owner, or their authorized representative.
6. "Cabling": A combination of all cables, wire, cords, and connecting hardware, e.g., cables, conductor terminations, connectors, outlets, patch panels, blocks, and labeling.
7. "ACAMS": Access Control & Alarm Monitoring System.
8. "SEC": Security Equipment Panels.
9. "VSS": Video Surveillance System.

## 1.4 SYSTEM DESCRIPTION

A. Overview: Reference project specific scope.

B. Drawings
1. Layout: Follow the general layout shown on the Drawings except where other work may conflict with the Drawings.
2. Accuracy: The Drawings show a diagrammatic representation of the system within the constraints of the symbology applied.
3. The Drawings do not fully represent the entire installation for the Security System. Drawings indicate the layout and location of control components, as well as location of security devices, i.e. card readers, door locks and contacts, glass break detectors, etc. The Drawings do not show all conduits, wire and cabling between every system component, equipment, device, etc.
4. Provide detailed point-to-point diagrams that allow the Contractor to achieve desired results using their own procedures and methods. Submit CAD shop drawings for review prior to installation.

C. Contractors Design Requirements
1. The Project Drawings represent the level of system design to be provided by the engineer. Contractor shall provide all additional system design work required, including:
   a. Conduit layout and sizing.
   b. Wire and cable layout and sizing including type and quantity.
   c. Point-to-point wiring and equipment hook-up information.
   d. Equipment mounting details.
   e. Design of equipment cabinets and interface components.
   f. System one-line or block diagram.
   g. Other detailed design work required.

h. Reflected ceiling plan for devices installed in ceiling.

2. Obtain shop drawings of other related systems that require integration and coordinate means and methods to complete the system as described and specified in these sections.

## 1.5 SUBMITTALS

A. General: Submit required submittal(s) in accordance with General Conditions of the Contract, and Division 1 Submittal Procedures Section 013300.

B. Cover Letter: Include a cover letter stating that the submittal is in full compliance with the requirements of the Contract Documents. List in full the items and data submitted, signed (and stamped, if applicable) by the person who prepared the submittal. Failure to comply with this requirement shall constitute grounds for rejection of submittal.

C. Submittal Description: Product Data

1. General: Product data submittals must be approved by the Owner prior to release of order for equipment and prior to installation.
2. Quantity: As noted in Division 1 (minimum of four).
3. Format:
   a. Provide each product data submittal in a 3-ring binder with front cover and spine clear pockets for insertion of the submittal information.
   b. Clearly label the cover and the spine of each submittal with the following information:
      1) Client Name (e.g., "CSM").
      2) Project Number and Contract Number.
      3) Project Name and Address (e.g., "Building 9").
      4) Contractor's Submittal Number.
      5) Submittal Title (e.g., "Product Data Submittal For ACAMS System").
      6) Specification Section Number (e.g., "Section 13710").
      7) Date of Submittal. Format: <month> <day>, <year> (e.g., "January 1, 2007").
      8) Contractor Name.
   c. Include a Table Of Contents at the beginning of the submittal that lists materials by article and paragraph number found in the section and in the order outlined in the specification (e.g., "2.03-b Card Reader").
   d. Include tabbed separators for improved navigation through the submittal.
   e. Delivery dates for all equipment.
4. Content:
   a. Product Information:
      1) Include product data consisting of manufacturer's technical data, product literature, "catalog cuts", data sheets, specifications, and block wiring diagrams (if necessary). This data shall clearly describe the product's characteristics, physical and dimensional information, electrical performance data, materials used in fabrication, material color & finish, and other relevant information such as test data, typical usage examples, independent test agency information, and storage requirements.
      2) Clearly indicate by arrows or brackets precisely what is being submitted on and those optional accessories, which are included and those which are excluded.
      3) Include delivery dates for equipment.

D. Submittal Description: Shop Drawings.

1. General: The Owner must approve shop drawings prior to release of order for equipment and prior to installation.

2. The Owner will provide electronic files via e-mail or via CD-ROM containing the contract documents drawing files for use in preparing shop drawings.
3. Quantity & Media: Furnish quantity and on media specified in Division 1.
4. Format:
   a. Use AutoCAD Release 14 or later.
   b. Use the same sheet size and project title block as the Drawings.
   c. Text a minimum of 3/32" high when plotted at full size.
   d. Use identical symbols as those in the Design Drawings.
   e. Screen background information.
   f. System components (devices, cable routes, etc.) and text shall be plotted at a sufficient line weight to stand out against background information.
   g. Each sheet in the shop drawings set shall be labeled with the Specification Section Number (e.g., "282300").
   h. Scaling:
      1) Floor plans shall be scaled at 1/8"=1'-0".
      2) Enlarged room plans shall be scaled 1/4"=1'-0".
      3) Wall elevations shall be scaled 1/2"=1'-0".
5. Content:
   a. Floor Plans:
      1) Floor and site plans showing the locations of all devices and door furniture associated with each door locations (ex: contacts, rex locks, card readers) and cable routing paths with cable type and quantity called out. Prepare cable schedule if required to simplify sheet plan notation.
      2) Provide termination information for each device on the plans or in a schedule that identifies the physical connections to the equipment panels. Include the panel address, and the termination point ID that is consistent and reflective of the programming fields.
   b. Point-to-Point Diagrams: Include all wiring, points of connection and interconnecting devices.
      1) Include all miscellaneous control relays.
      2) Include all devices connected to the system.
      3) Identify all conductors on the point-to-point diagrams with the same tag as the installed conductor.
   c. Block Diagram/Riser Diagram: Show the system components and all conduit and wire types and sizes between them including all cabling interties between termination hardware.
   d. Installation Details: Include installation details for all devices.
   e. Seismic Calculations: As part of the shop drawings submittal where applicable, the manufacturer shall provide anchorage calculations for floor mounted fully loaded distribution frames such that it shall remain attached to the mounting surface after experiencing forces in conformance with CCR, Title 24, Table 23P, Part II and with Section 2312 "Earthquake Regulations" of the "Uniform Building Code" for Seismic Zone 4 Area, Importance Factor of 1.25. Structural Calculations shall be prepared and signed by a California Registered Structural Engineer. Specify proof loads for drilled-in anchors, if used. Seismic calculation shop drawings shall be wet stamped and signed by a registered structural engineer.

E. Submittal Description: Labeling Sample.
1. Quantity & Media: Furnish quantity indicated in Division 1.
2. Submit two sets of physical product samples for review and comment by Owner prior to the installation of equipment:
3. Content:
   a. Provide panel label.
   b. Provide cable label on a cut length of cable.

F. Submittal Description: Record Drawings.
1. Quantity & Media:
   a. Submit a single set of half size prints of record drawings for review by the Owner.
   b. Upon receipt of the Owner's review comments, make corrections and furnish the following record drawings:
      1) Four half-size sets on bond (or "eco-bond").
      2) One CD-ROM.
      3) One 11x17 set in the Record Documents Manual.
   c. Drawings become Owner's property and shall maintain all ownership rights.
2. Format:
   a. Prepare record drawings using AutoCAD Release 14 or later.
   b. Use the same sheet size and project title block as the Drawings.
   c. Text a minimum of 3/32" high when plotted at full size.
   d. Use identical symbols as those in the Drawings.
   e. Screen background information.
   f. All system components (devices, cable routes, etc.) and text shall be plotted at a sufficient line weight to stand out against background information.
3. Content:
   a. Fully represent actual installed conditions and incorporate all revisions made during the course of construction.
   b. Include drawings submitted as part of the Shop Drawing package, plus any additional information required to accurately document installed conditions.
   c. Device addresses & IP address information.
   d. Floor plans shall show:
      1) Locations and identifiers of all devices.
      2) Size, quantity, location, and routes of all pathways (such as cable trays, conduits, J-hangers, and other cable support devices).
   e. Equipment room floor plans scaled at 1/2"=1'-0" showing exact placement of all equipment cabinets/frames, rack bays, and other equipment.
   f. Wall elevations scaled at 1"=1'-0" showing exact placement of all security system hardware (e.g., SECs,).
   g. Installation details.

G. Submittal Description: Operation and Maintenance Manuals
1. Quantity: Furnish four O & M Manuals.
2. Format:
   a. Furnish each O & M Manual in a white, 3-ring binder with front cover and spine clear pockets for insertion of the project information.
   b. Clearly label the cover of each O & M Manual with the following information:
      1) Client Name.
      2) SMCCCD Project and Contract Numbers.

3) Project Name and Address.
4) Manual Name (e.g., "Operation And Maintenance Manual for ACAMS System).
5) Date of Submittal. Format: <month> <day>, <year> (e.g., "January 1, 2007").
6) Contractor Name.

c. Include a Table Of Contents at the beginning that lists the contents.
d. Include tabbed separators for improved navigation through the manual.

3. Content:
a. Functional Design Manual: Includes a detailed explanation of the operation of the system.
b. Hardware Manual which includes:
1) Pictorial parts list and part numbers.
2) Pictorial and schematic electrical drawings of wiring systems, including devices, control panels, instrumentation and annunciators.
3) Telephone numbers for the authorized parts and service distributors.
4) Include all service bulletins.
c. Operator's Manual which full explains all procedures and instructions for the operation of the system and includes:
1) System start up and shut down procedures.
2) Use of system.
3) Equipment recovery and restart procedures.
4) Reader command functions
d. Maintenance Manual which includes:
1) Instructions for routine maintenance listed for each component, and a multi-page summary of all components' routine maintenance requirements.
2) Detailed instructions for repair of the security system.
3) A summary of the TCP/IP address used and which system component they are associated with. Include the gateway address, subnet mask, DNS server, and host name information.
4) Manufacturer's warranty certificates.
e. Record Drawings Manual: 11"x17" prints of Record Drawings, as described above.

H. Resubmittals: Include a cover letter listing the action taken and revisions made to each product submittal in response to Submittal Review Comments. Resubmittal packages will not be reviewed unless accompanied by this cover letter. Failure to include this cover letter will constitute rejection of the resubmittal package.

## 1.6 QUALITY ASSURANCE

A. Contractor Qualifications
1. Primary business locations from which project management, installation technicians, and service personnel are dispatched must be within 50 miles of the city of San Mateo, to ensure response time for technical assistance within 4 hours.
2. At least 5 years of experience, and a minimum of five satisfactory completed projects similar in scope and cost.
3. Provide a resume of satisfactory evidence of project manager, foreman, and lead technician's qualifications and certifications by the manufacturer for the work.
4. A current AMAG "Global Security Management" Certification indicating that contractor has attended training and successfully completed the training course.
5. A current, active, and valid C7 or C10 California State Contractors License.

6. Authorized reseller/dealer, warranty provider, and a factory certified installer of the AMAG security system at the Global Level.

B. Permits and Inspections
   1. Obtain and pay for permits and inspections required for the work.
   2. Furnish materials and workmanship for this work in conformance with applicable legal and code requirements.

C. Perform tests required herein, or as may be reasonably required to demonstrate conformance with the Specifications or with the requirements of any legal authority having jurisdiction.

D. Obtain review from compliance officials responsible for enforcement of applicable codes and regulations to establish that the work is in compliance with all requirements of reference codes indicated herein.

E. Materials
   1. Provide new and unused materials, equipment, and parts of current manufacturer, and without defects for the units specified herein.
   2. Furnish only specified products and equipment, or products and equipment that have been approved in writing.

F. Regulatory Requirements
   1. Work and materials shall conform to the latest rules of National Board of Fire Underwriters wherever such standards have been established and shall conform to the regulations of the State Fire Marshal, OSHA and the codes of the governing local municipalities. Nothing in these specifications is to be construed to permit work not conforming to the most stringent of the applicable codes.
   2. Reference to codes, standards, specifications and recommendations of technical societies, trade organizations and governmental agencies shall mean that latest edition of such publications adopted and published prior to submittal of the bid. Consider such codes or standards a part of this Specification as though fully repeated herein.
   3. When codes, standards, regulations, etc. allow work of lesser quality or extent than is specified under this series of Sections, nothing in said codes shall be construed or inferred authority for reducing the quality, requirements or extent of the Drawings and Specifications. The Contract Documents address the minimum requirements for construction.

## 1.7 PROJECT MANAGEMENT AND COORDINATION SERVICES

A. Overview: Provide a project manager/engineer for the duration of the project to coordinate the security system work with all other trades. Coordination services, procedures and documentation responsibility shall include, but shall not be limited to the items listed in this section.
   1. Obtain copies of all shop drawings and product data for equipment provided by others that require security connections or interface with the security system work.
   2. Prepare and maintain a shop drawing review log indicating the following information:
      a. Shop drawing number and brief description of the system/material.
      b. Date of your review.
      c. Indication if follow-up coordination is required.

B. Request for Information (RFI)
1. Thoroughly review the contract documents prior to the preparation and submission of an RFI. If an RFI is submitted, attach 8 1/2" x 11" copies of all relevant documents to clarify the issue.
2. Prepare and maintain an RFI log using a Microsoft Excel spreadsheet indicating the following information:
   a. RFI number and brief summary of the issue.
   b. Date of issuance and receipt of response.

C. Scheduling of Work
1. Prepare work schedules for each floor indicating the following information:
   a. Cable installation dates.
   b. SEC buildout dates.
   c. Device installation dates.
   d. Programming dates.
   e. Testing dates.

D. Role of the Engineer
1. During the construction phase of the project, the Engineer will work with the Contractor to provide interpretation and clarification of project contract documents, reply to (and 'process') relevant Requests for Information (RFIs), and act as an interface between the Contractor and the Owner.
2. The Owner has retained the Engineer's services to observe the Work for general compliance with the Contract Documents and to ensure that the installation meets the design intent of the system.
3. In summary, the Engineer will perform the following specific services during the construction phase:
   a. Review product submittals and shop drawings for general compliance with the contract drawings and specifications.
   b. Review changes as they arise, and confirm that the proposed solutions maintain the intended functionality of the system.
   c. Interpret field problems for Owner, and translate into understandable language.
   d. Review the testing procedures to confirm compliance with industry-accepted practices.

## 1.8 DELIVERY, STORAGE AND HANDLING

A. Delivery
1. Do not deliver products to the site until protected storage space is available. Coordinate delivery of materials with scheduled installation date to allow minimum storage time at jobsite.
2. Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels (name of the manufacturer, product name, type, grade, UL classification, etc.) intact.
3. Replace materials damaged during shipping at no cost to the Owner.

B. Storage
1. Store materials in clean, dry, ventilated space free from temperature and humidity conditions (as recommended by manufacturer) and protected from exposure to harmful weather conditions.
2. Comply with manufacturer's requirements for each product. Comply with recommended procedures, precautions or remedies as described in the Material Safety Data Sheets (MSDS) as applicable.

3. Maintain factory wrapping or provide a heavy canvas/plastic cover to protect units from dirt, water, construction debris, and traffic.
4. Storage outdoors covered by rainproof material is not acceptable.
5. Provide heat where required to prevent condensation or temperature related damage.

C. Handling
1. Handle in accordance with manufacturer's written instructions.
2. Damaged equipment shall not be installed.
3. Replace damaged equipment at no cost to the Owner.
4. Handle with care to prevent internal component damage, breakage, denting, and scoring.

## 1.9 WARRANTY

A. Provide a one-year parts and service warranty at no additional cost to the Owner.

B. Warranty begins when system commissioning is completed, punchlist items resolved, and Owner provides in writing acceptance of system.

C. The warranty package shall include but not necessarily be limited to the following:
1. Emergency maintenance service on regular working hour basis.
2. Service by factory trained and employed service representatives of system manufacturer.

D. Maintain regular service facilities and provide a qualified technician familiar with this work at the site within four (4) hours of receipt of a notice of malfunction including weekends and holidays. Provide material, devices equipment and personnel necessary for repairs. Install approved temporary, alternate equipment if required by the Owner, complete and operational within twenty-four (24) hours after notification of a malfunction, at no additional cost.

E. Conduct warranty repairs and service at the job site unless in violation of manufacturer's warranty; in the latter event, provide substitute systems, equipment and/or devices, acceptable to the Owner, for the duration of such off-site repairs. Transport warranty substitute and/or test systems, equipment, devices, material, parts and personnel to and from the job site at no additional cost.

# PART 2 - PRODUCTS NOT USED – REFER TO ADDITIONAL SECURITY SECTIONS FOR PRODUCT DETAIL.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

A. Verify existing conditions, which have been previously installed under other sections, are acceptable for product installation in accordance with manufacturer's instructions.

B. Verify that all penetrating elements and supporting devices have been properly installed, and that all temporary lines, and markings, have been removed.

## 3.2 PREPARATION

A. Staffing
1. Provide a qualified foreman in charge of the work at all times and be present at the job site at all times during the installation of the work.
2. Provide a supervised work force capable of performing the installation within the restraints of the construction schedule.

B. Project Management
1. Prepare an overall construction schedule based on the results of the planning meetings with the Owner.
2. Prepare updated schedules whenever there are modifications. Coordinate and attend weekly status meetings to review the overall progress and issues to be resolved throughout the course of construction. The Contractor is responsible for preparing and distributing meeting agenda prior to and meeting notes after all meetings in a format acceptable to the Owner.

## 3.3 INSTALLATION

A. General
1. Perform this work in accordance with acknowledged industry and professional standards and practices and the procedures specified herein.
2. The work shall be performed by skilled installers under the direction of experienced technician, all of whom shall be properly trained and qualified for this work.
3. A complete, operating system shall be provided. Include all devices specified including basic components and accessories, interconnecting wiring and other equipment and installation devices necessary for a complete system as specified.
4. Provide wire, system cabinets, system devices, etc., shall be in accordance with applicable codes for systems as specified. Label all wiring and equipment.
5. The control equipment and wiring shall be installed in a neat and workmanlike manner by trained mechanics or electricians.
6. Auxiliary and incidental equipment necessary for the operation and protection of the systems specified in this section shall be furnished and installed as if specified in full herein.
7. Install the Security System with the full support of the manufacturer of the system components.

B. Coordination: Maintain a competent supervisor and supporting technical personnel, acceptable to the Owner during the entire installation. Change of supervisor during the project shall not be acceptable without prior written approval from the Owner.

C. Boxes, Panels, and Enclosures
1. Install all boxes, panels, and enclosures square and plumb. Set "flush mounted" units so that the face of the cover, bezel or escutcheon shall be in the same place as the surrounding finished surface. Mount boxes, panels and trim so that there are no gaps, cracks or obvious lines between the trim and the adjacent finished surface and ready them to receive final finish, as applicable.
2. Install insulating terminations in signal circuit boxes, panels, wireways or enclosures of this section.
3. Write the destination for every conduit entering a door junction box, SEC enclosure, or wireway using a black permanent ink marker next to the conduit inside the box.

4. Provide tamper switches on all enclosures that are accessible and below the ceiling.

D. Painting: Custom paint devices as indicated on the drawings.

## 3.4 REPAIR/RESTORATION

A. Replace or repair work completed by others that you deface or destroy. Pay the full cost of this repair/replacement.

B. Punch List:
1. Inspect installed work in conjunction with the General Contractor and develop a punch list for items needing correction.
2. Provide punch list to Owner for review prior to performing punch walk with the Owner.

C. Re-Installation:
1. Make changes to adjust the system to optimum operation for final use. Make changes to the system such that any defects in workmanship are correct and cables and the associated termination hardware passes the minimum test requirements.
2. Repair defects prior to system acceptance.

**END OF SECTION**

# SECTION 28 05 13

# SECURITY SYSTEM CABLING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. General: Furnish engineering, labor, materials, apparatus, tools, equipment, transportation, temporary construction and special or occasional services as required to make a complete working security system installation, as described in these specifications.

B. Section Includes: Wiring and cable.

C. Related Sections:
1. Consult other Divisions; determine the extent and character of related work and properly coordinate work specified herein with that specified elsewhere to produce a complete and operable system.
2. Section 280000: Basic Security System Requirements.
3. Section 281300: Access Control and Alarm Monitoring System.
4. Section 282300: Video Surveillance System.
5. Section 280553: Security System Labeling.
6. Section 280800: Security System Commissioning.
7. Section 078400: Firestopping.
8. Section 260533: Raceways and Boxes.

### 1.2 SUBMITTALS

A. Submit in accordance with the requirements of Section 280000: Basic Security System Requirements, the following items: Product Data.

## PART 2 - PRODUCTS

### 2.1 WIRE AND CABLE

A. General
1. Provide all necessary cable supports and J-Hangers dedicated for security cable
2. Do no share conduits with fire alarm or telecommunications systems.
3. Provide required wire and cable sized to allow for voltage drop on long runs and effectively shielded as required to allow the routing of 12 & 24V power and video signal cable in the same conduit without interference or signal noise.
4. Cable installed outdoors or in underground conduit must contain a PVC or Polyethylene jacket, flooded to prevent water intrusion.
5. Cables installed outdoors or in underground conduit that transition into the building and run in plenum space to contain a plenum rated (type CMP) jacket and contain water block material to prevent water intrusion.
6. Cables installed indoors to contain a plenum rated jacket (type CMP).

B. Manufacturers:
1. Westpenn.
2. Belden.
3. Commscope.
4. Or Equal.

C. Access Control System
1. Provide plenum rated cable by Westpenn, Belden, Commscope, or equal.
   a. #22-4 conductor unshielded: door contacts, glass break detectors, rex detectors.
   b. #16-2 AWG unshielded: low current lock power.
   c. #16-2 AWG unshielded: Lock power from PS-873 to Exit Device (panic hardware).
   d. #18-2 AWG unshielded: Low current relays and card reader power.
   e. #22/2 pr unshielded: 20mA card reader data.
   f. #22-8 conductor unshielded: Door Management and Exit Alarms.
2. Provide self-adhesive flat tapewire on all existing wood doors for lock power transfer from hinge to lock.
   a. Install tape wire in routed channel along edge of door.
   b. Fill channel with silicone after lock has been tested.
   c. Manufacturer: Taperwire 222-CL.
   d. Refer to architectural details and section 8212 Flush Wood Doors for additional information.
   e. Power locks to ensure continuity of circuit.
   f. Refer to Section 08710 and door schedule in Section 13710 for locations.

D. Video Surveillance System
1. Provide plenum rated cable by Westpenn, Belden, Commscope, or equal. #18-2 AWG unshielded: camera power.
2. Provide minimum RG-59/U CCTV video coaxial cable between the camera and the monitoring equipment, with the following features:
   a. 95% percent copper braid.
   b. Foam dielectric.
   c. Solid copper core.
   d. 75 ohm characteristic impedance.
   e. Plenum jacket.
3. Manufacturer: West Penn #25815.
4. Provide West Penn #825 with a black jacket for CCTV video cross-connect/patch cabling under 15' in length.

## 2.2 SURFACE MOUNTED RACEWAY

A. General
1. Surface mounted raceways are required at card reader doors that are set in existing concrete openings and the opportunity for concealed in wall conduit is not available.
2. Provide surface mounted steel raceways according to door details and where devices are visible and no accessible ceiling exists. Exceptions include MEP spaces and IT rooms.
3. Fasten raceway to concrete with 1/4" TAPCON anchors or approved equal.
4. Size raceways to accommodate feeder cables to junction box at doors and from junction boxes to devices.
5. Manufacturer: Wiremold V500/V700 & V4000 Raceways Use combinations of series to accommodate cable fill and junction boxes.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Identify all wire and cable clearly with permanent labels wrapped about the full circumference within one (1) inch of each connection. Indicate the number designated on the associated field or shop drawings or run sheet, as applies. Assign wire or cable designations consistently throughout a given system; i.e., each wire or cable shall carry the same labeled designation over its entire run, regardless of intermediate terminations. Additionally, provide labels where wire and cable first enter and exit from conduit, junction or distribution boxes; labels shall be located within six (6) inches of the point of exit. Labels shall be by Brady, Thomas and Betts, or equal.

B. Secure all wire and cable run vertically in conduit for continuous distances greater than thirty (30) feet at the vertical run terminations. Non-coaxial cables shall be secured by screw-flange nylon cable ties or similar approved devices, Thomas and Betts or equal. Symmetrical clamping devices with split, circular or other wire conforming, nonmetallic bushings shall be provided for all other cables.

C. All wire and cable shall be continuous and splice-free for the entire length of run between designated connections or terminations.

D. Make all connections to screw-type barrier strips on panels and with insulated crimp-type spade lugs when appropriate. Size all lugs properly to assure high electrical integrity, i.e., low resistance connections.

E. Lace, tie or harness wire or cable as required herein, and in accordance with accepted professional practice. 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.

F. Wiring for shielding certain conductors from others or routing in separate raceways, shall be as recommended by the manufacturer's current requirements.

G. All wiring shall be installed in a continuous steel conduit system when not located above accessible ceiling and shall be of the size recommended by the equipment supplier.

H. Provide all necessary tie wires.

I. Label all cables at both ends of a run and within all pull and junction boxes using machine generated wrap-around labels.

J. Follow manufacturers recommended guidelines for installation.

**END OF SECTION**

# SECTION 28 05 53

# SECURITY SYSTEM LABELING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. General: Furnish engineering, labor, materials, apparatus, tools, equipment, transportation, temporary construction and special or occasional services as required to make a complete working security system installation, as described in these specifications.

B. Section Includes: Labeling.

C. Related Sections:
1. Consult other Divisions, determine the extent and character of related work and properly coordinate work specified herein with that specified elsewhere to produce a complete and operable system.
2. Section 280000: Basic Security System Requirements.
3. Section 281300: Access Control & Alarm Monitoring System.
4. Section 282300: Video Surveillance System.
5. Section 280513: Security System Cabling.

### 1.2 SUBMITTALS

A. Submit in accordance with the requirements of Section 280000: Basic Security System Requirements, the following items:
1. Product Data.
2. Label Samples: Submit the following for review and comment prior to the and installation of equipment:
   a. Enclosure labels.
   b. Wire and cable labeling detail for all termination points.
   c. Include physical samples of each labeling material.

## PART 2 - PRODUCTS

### 2.1 LABELS

A. Phenolic two tone for exterior mounting on Enclosures. White lettering on black background.

B. Wire and Cable labels:
1. Provide self-laminating adhesive laser labels.
2. Labels shall be machine printable with a laser printer.
3. Text Attributes:
   a. Black.
   b. 1/8" high, minimum, or #12 font size.
   c. Font: Verdana preferred, SansSerif, or Arial acceptable.
4. Printable area: 1.0" X .375" and 1.0" X 0.50".
5. Cable size: 0.16 – 0.32" OD.
6. Color: White.

7. Manufacturer:
   a. Brady wire marking labels WML–211-295 and WML-311-292.
   b. Thomas and Betts.
   c. Or Equal.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Label all wiring and equipment.

B. Identify wire and cable clearly with permanent labels wrapped about the full circumference within one (1) inch of each connection. Indicate the number designated on the associated field or shop drawings or run sheet, as applies. Assign wire or cable designations consistently throughout a given system; i.e., each wire or cable shall carry the same labeled designation over its entire run, regardless of intermediate terminations. Additionally, provide labels where wire and cable first enter and exit from conduit, junction or distribution boxes; labels shall be located within six (6) inches of the point of exit.

C. Label all cables at both ends of a run and within all pull and junction boxes using machine generated wrap-around labels.

D. Boxes, Panels, and Enclosures
   1. Write the destination for every conduit entering a door junction box, SEC enclosure, or wireway using a black permanent ink marker next to the conduit inside the box.
   2. Install approved labels on the outside of each SEC and relay termination enclosures.

### 3.2 LABELING

A. General Requirements
   1. Physically label all of the security system components. The components include, but are not limited to, the following:
      a. Enclosures.
      b. Cables (both ends).
      c. Terminal blocks.
      d. Relays.
      e. Patch panels, and the termination positions within the patch panels.
   2. The ends of all cables must be permanently marked with machine-generated or stenciled (not handwritten) wrap around labels with a self-laminating feature, according to current practice and as approved by Owner before installation.
   3. Components, such as racks and patch panels, must be permanently marked with machine-generated labels, according to current practices and as approved by the Owner before installation.
   4. Labels shall coincide with device id's use on the record drawings.

B. Equipment Enclosures
   1. Label all Enclosures, alarm monitoring, and powers supply enclosures associated with the security system with an adhesive backed phenolic label. Use 12 point text.
   2. Labels shall be represented in and match the security system record drawings.

C. Security Devices
1. Label all equipment associated with the security system with a permanent machine generated, laminated, label. Use 12 point text with a clear background. Use white or black lettering depending upon the color of the device.
2. Label device in a concealed location with the system point number and address.
3. Label power supply batteries with the month and year they were installed.

D. Wire and Cable
1. Label all wire and cable associated with the security system with permanent machine generated, laminated, labels. Use 12 point, black text on a white label.
2. All wire and cable labels shall be clearly visible without the need to remove wire management or any other obstructions.

E. Cable Label Format
1. Obtain label format document from District or use the following:
2. From Panel to Field Device
   a. Line 1: Device Type and Device Number.
   b. Line 2: Panel ID – Port Number.
   c. Example: CR 001.
   d. Standard Device Types: ACU 1-KP5.
3. KP = Keypad
   a. R = Relay Output.
   b. A = Alarm Point.
   c. Standard Port number
      1) M = Monitored Input.
      2) R = Relay Output.
4. Miscellaneous Examples:
   a. From Panel to Door Contact.
   b. A001.
   c. D.C.
   d. From Panel to Glass Break.
   e. A001.
   f. GB PWR.
   g. 12 VDC.
5. Communications Cable
   a. Line 1: Communication Type and Direction.
   b. Line 2: Panel ID.
   c. Example: 20MA TO.
   d. Typical Communication Types: ACU-2.
   e. 10BASE-T.
   f. RS485.
   g. RS 232.
   h. RS 422.
   i. 20mA.

**END OF SECTION**

# SECTION 28 08 00

# SECURITY SYSTEM COMMISSIONING

## PART 1 - GENERAL

### 1.1 SCOPE OF WORK

A. General: Furnish all engineering, labor, materials, apparatus, tools, equipment, and transportation required to test a completed security system installation as described in these specifications.

B. Base Bid Work: Full testing of completed security system which includes:
1. Complete pretest of the security system.
2. Final walk test with the Owner.
3. Test Results Record Documentation.

C. Related Sections:
1. Consult all other Divisions, determine the extent and character of related work and properly coordinate work specified herein with that specified elsewhere to test a complete and operable system.
2. Section 280800: Basic Security System Requirements.
3. Section 281300: Access Control and Alarm Monitoring System (ACAMS).
4. Section 282300: Video Surveillance System.

### 1.2 SUMMARY OF SYSTEM COMMISSIONING ACTIVITIES

A. Overview
1. The purpose of system commissioning is to ensure the security system operates properly when it is needed most. Security systems are very complex from both equipment and programming standpoint, and thorough testing is necessary to ensure correct operation.
2. Perform testing activities when the system is "quiet" and the building is generally unoccupied. This will minimize the amount of irrelevant activity in the system activity reports that will be used as a record of the pre and final test results.

B. Pre-Test
1. Perform a 100% pre-test of all system aspects to verify correct operation prior to scheduling the final test. The pre-test will help to make the final test run smoothly when demonstrating the system's operation to the Owner.
2. Document the results of the pre-test using the approved test forms and submit a copy to the Owner along with the system activity reports.

C. Final Test: Perform a final test of the system in the presence of the Owner to demonstrate correct operation of the security system.

### 1.3 SUBMITTALS

A. Submit in accordance with the requirements of Section 280000: Basic Security System Requirements, the following items:
1. Sample Test forms: Provide sample test forms that will be used in the pre and final system tests. Furnish the required quantity of each submittal indicated in Division 1.

2. Operation and Maintenance Manuals: Submit the following for review and comment at the completion of the project and before final testing occurs:
   a. Functional Design Manual.
   b. Hardware Manual.
   c. Software Manual which includes.
   d. Operator's Manual which full explains all procedures and instructions for the operation of the system and includes.
   e. Maintenance Manual.
   f. Test Results Manual, which includes the document results of all tests, required under this Specification, organized by System, Floor, and Door.
   g. Record Drawings Manual.
3. Record Drawings:
   a. Submit for review and comment at the completion of the project.
   b. Final acceptance will not be made until the record drawings approved by the Owner.

## 1.4 QUALITY ASSURANCE

A. General: All testing work shall be completed in a neat, high quality manner acceptable to the Owner.

B. Project Management and Coordination Services: Provide a project manager to coordinate the security system commissioning work with all other trades.

## PART 2 - PRODUCTS: NOT USED

## PART 3 - EXECUTION

## 3.1 SCHEDULING

A. Prepare a construction schedule based on the schedule developed in Section 280000 for the testing activities. Prepare updated schedules whenever there are modifications.

## 3.2 TESTING REQUIREMENTS

A. Site Tests
   1. Perform a 100% pretest of the system prior to final testing by the Owner. Provide the Owner with a minimum of a 5-day notice prior to scheduling testing.
   2. At the conclusion of the work on a floor, test the system on that floor to verify proper operation and reporting of devices.
   3. Work with the door hardware supplier to resolve any electric hardware failures and door alignment/closure problems.
   4. At the completion of all work, test the entire system to verify proper operation. These tests shall include:
      a. Card Reader Door Test: Test doors to ensure alarm contact provide alarm activation and relock when closed, rex shunts door and command card reader bypasses alarm inputs for area when applicable.
      b. Card Reader/ADA Test:Test doors according to card reader test above. In addition, test ADA push plate interlocking function to ensure door does not operate when locked. Test that interior ADA actuator always functions.
      c. Card Reader/ Holder Test: Test doors according to card reader test above. In addition test magnetic holder interlock function to ensure doors cannot be propped when locked.

d. Elevator In-Cab Reader Test:Enable after hours scheduled securing of elevator floor select buttons. Program a card for each floor with only one-floor privileges. Present card 1 and select floor each floor one at a time. Floor 1 shall function while other floors should not. Repeat test with other cards and floors.

e. Elevator Hall-Call Reader TestEnable after hours scheduled securing of elevator. Program single card with privileges to all hall select buttons. Present card at floor 1 and press hall select button. Hall select button should function. Have second technician attempt to use hall button on other floors at same time to ensure independent operation.

f. In/Out Card Reader Test:Test door according to card reader test above. In addition test door management alarm for instant alarm on forced exit/entry, remote reset recycle upon card presentation for authorized passing through door. Door held function post authorized card presentation.

g. RS232 Modem Dialup TestTest modem functionality for alarms to District Headend. Disconnect network at panel and initiate panel alarm. Modem should dial and connect to head end. Confirm activity at head end workstation.

h. CCTV Recording System Test:Test the recording system for correct programming, alarm recording, and event retrieval. Verify correct integration with the ACAMS system for alarm call-up. Test and verify CCTV system viewable from workstations.

i. Security Equipment Room Test:Inspect all system panels, power supplies, and other related security equipment located in these areas.

j. Access Control:Test the software for correct programming and setup to activate door schedules, elevator interface and test cards.

B. Test Preparation

1. Provide device identification numbers that differ from or were not included on the original contract drawing set.
2. Furnish a complete systems point list.
3. Furnish paper and toner for the printer so that an event log can be printed out and attached to the test reports as verification of test sequence and systems response.
4. During testing, provide a minimum of two technicians familiar with the installation to assist with the test. Stage the technicians as follows: one at the host and one at the device being tested.
5. Furnish radios for use by the Owner during testing.
6. Furnish pre-programmed access cards for use during testing. One card shall be provided for each access level.

## 3.3 TEST PROCEDURES

A. Prepare and issue for review test forms for each door and device type.

## 3.4 DOCUMENTATION

A. Provide a full-sized blueline drawing containing a detailed wiring diagram (layout of equipment/elevation, complete parts list, and a complete wiring diagram for each ACU & I/O Board) for each SEC. Fold the diagram and place it inside a clear plastic pocket affixed to the inside door of the SEC.

B. Provide a service log on the inside door of each SEC. Service log shall include columns for the following information: date of service, description of work performed, service technician(s), and service company. Place the service log inside a separate clear plastic pocket affixed to the inside door of the SEC.

## 3.5 DEMONSTRATION

A. On completion of the acceptance test, provide the Owner instruction in the operation and testing of the system, at a time convenient to them.

B. Utilized the database for the project during training to give the users a project specific example to learn from.

C. Provide a minimum of 8 hours of on-site training for the both the ACAMS and Video Surveillance System by a factory-trained representative. Conduct separate training sessions for system administrator, system supervisor, and operator level users

D. Maintain a sign in sheet with names and dates of all persons trained and forward to Owner upon completion of training.

**END OF SECTION**

# SECTION 28 13 00

# ACCESS CONTROL & ALARM MONITORING SYSTEM (ACAMS)

## PART 1 - GENERAL

### 1.1 SUMMARY

A. General: Furnish engineering, labor, materials, apparatus, tools, equipment, transportation, temporary construction and special or occasional services as required to make a complete working Access Control and Alarm Monitoring system installation, as described in these specifications.

B. Section Includes:
1. Access control and alarm monitoring, including access control units, input/output units, card readers, door contacts, rex detectors and door management alarms, and gals break detectors.
2. Interface to electric door hardware.
3. ACAMS Power supplies.
4. Lock Power Supplies.
5. Interface to fire life safety system magnetic door release service.
6. Interface to elevator control system.
7. Interface to central station alarm monitoring.

C. Products Supplied But Not Installed Under This Section: Elevator card readers.
1. Provide card reader to elevator contractor to install on car operating panel.
2. Remove installed reader and make connections to reader from cable in traveler and remount to existing machine tapped mounting holes.

D. Products Installed But Not Supplied Under This Section: Exit Device (panic bar) Power Supplies.

E. Products Specified But Not Installed Under This Section: Type 1 enclosures at pull box and elevator junction box locations.

F. Products Furnished and Installed Under Another Section:
1. Local area network.
2. Data cable to network port.
3. Voice cable and connections to District.
4. 120V power to system.
5. Elevator traveler cable for card reader.
6. Magnetic door holders.
7. Electrified locking hardware.

G. Related Sections:
1. Consult other Divisions; determine the extent and character of related work and properly coordinate work specified herein with that specified elsewhere to produce a complete and operable system.
2. Section 087100 Door Hardware: includes product information for electrified locking hardware and magnetic door holders.
3. Section 280000 Basic Security Requirements: includes general project requirements, submittal formats, warranty, and installation requirements and additional sections for reference.
4. Section 282300 Video Surveillance System: includes product information for video integration with the ACAMS.

5. Section 280513 Security System Cabling: includes product information for wire and cable needed to support the ACAMS.
6. Section 280553 Security System Labeling: includes label types and formats for security devices.
7. Section 280800 Testing/Commissioning: includes the integrating testing/commissioning requirements for the ACAMS.

## 1.2 SYSTEM DESCRIPTION

A. Overview: Refer to Division 1 and Section 280000 for general description.

B. Base Building Access Control & Alarm Monitoring System (ACAMS).
1. The ACAMS system will control access control into the building and select interior doors as indicated on the plans. Intrusion alarm monitoring, comprised of door contacts and glass break detectors, is consolidated to the ACAMS system eliminating the need for a conventional burglar alarm panel.
2. Elevator Access Control:
   a. Elevator – Hall Call.
      1) Access is restricted after hours by disabling the hall call buttons on each floor.
      2) On schedule the hall buttons, through hardwired integration between the ACAMS and elevator controller, will become inactive and unresponsive to calls.
      3) Each hall call button on floors to be access controlled will include an adjacent card reader. Valid card readers will momentarily enable the call button for use and call the elevator to that floor.
      4) Car Operating Panel floor select buttons are always unrestricted.
   b. Elevator – Interior Elevator.
      1) Access is restricted after hours by disabling the Car Operating Panel floor select buttons.
      2) On schedule the floor select buttons, through hardwired integration between the ACAMS and elevator controller, will become inactive.
      3) A single card reader installed in the elevator on the Car Operating Panel momentarily enables specific floor selection buttons and allows travel to floors.
      4) Hall call buttons are always unrestricted.
3. Select Interior card readers shall be proximity "Command Card" readers and allow select cardholders to execute preprogrammed commands from the reader numerical keypad. For this scope of work program commands to arm/disarm the door contacts and interior intrusion devices for each space the card reader gains access to with either card plus key command or just key command. Exterior perimeter doors are excluded from card commands.
4. In/Out card readers with door management alarms restrict access to select areas of building and maintain separation between leased space and the building common.
5. Create schedules to automate the opening and closing of the building including unlocking doors, bypassing alarms, and unrestricted elevator access.
6. Connect the ACAMS system to the Districts existing head end utilizing the LAN/WAN and secondary redundant RS232 communications over modems in the event network failure occurs. The first panel in the hub cluster will connect to the IT switch located in the building. All downstream panels are hardwired on a 20mA loop.
7. Provide duress buttons at all public service counters or cash exchange locations. Duress buttons will connect auxiliary inputs on the ACAMS panels.

8. Program conditional commands to output ASCII data to alarm translator/dialer for connection to central station alarm monitoring company. Meet with District to determine unique grouping requirements.

C. Custom Device Requirements
1. Interconnect magnetic door holders on select card reader doors to prevent after hours propping (refer to plans for locations.
   a. Interlock magnetic holder power through control relay on Von Duprin PS-873. Relay automatically follows lock power state.
   b. When door is locked power to magnetic holders is cut.
   c. When door is unlocked on schedule, during class hours, power is routed to magnetic holders and door can be propped.
   d. Fire alarms will disconnect power from magnetic holders and release door and is not affected by interconnections to ACAMS.
2. Connect all low voltage cables between lock power supplies, transfer hinges, and locks.
3. Interconnect ACAMS system to ADA operators for secure after hour's operation as indicated in drawings.
   a. Interlock exterior ADA push plates with aux relay on PS-873.
   b. When door is locked exterior push plate is disabled.
   c. When door unlocked, even momentarily, ADA push plate is enabled.

D. Tamper Monitoring
1. Provide additional monitor input points for monitoring the following:
   a. Tamper switches located within each security equipment enclosure and wire way.
   b. Supervision of power supplies and batteries.

## 1.3 SUBMITTALS

A. Contractor Qualifications: Submit certification letters for the manufacturer of the ACAMS.

B. Product Data: Submit product information for components specified herein. Refer to Section 280000 for format and requirements.

C. Shop Drawings: Submit shop drawings in accordance with Division 1. Refer to Section 280000 for format and requirements.

# PART 2 - PRODUCTS

## 2.1 MANUFACTURERS

A. Access Control and Alarm Monitoring System

B. The ACAMS system is manufactured by Group 4 Technologies AMAG. Pursuant to Section 3400 of the Public Contract Code: AMAG Access Control and Alarm Monitoring System is now in use on the particular public improvement described as San Mateo County Community College District. At each instance in these specifications that "AMAG" is designated by brand name, said manufacturer's system is required and is designated to coordinate with existing systems that are in place at Skyline College, College of San Mateo, Cañada College and the District Administration Building. The Contractor will furnish and install only "AMAG" systems and devices as required, and no substitutions shall be deemed to be "or equal" or allowed.

C. Card Readers: AMAG Technologies.

D. Power Supplies: Altronix.

E. Intrusion Devices
1. GE Security.
2. DSI.

## 2.2 ACCESS CONTROLLERS

A. General: 8-door controller capable of expanding to 16 with modular additions, including battery backup, database, user defined reports, and several communication ports. Controller shall serve as a consolidation and control point for all security related field devices including card readers, lock control, elevator control, and intrusion detection devices. Specifically the core functions of the controller are as follows.
1. Central control for devices attached.
2. Makes decisions for access without reliance on communications to host or other field panel.
3. Executes scheduled events such as unlocking doors or bypassing alarms.
4. Responds to monitor activity.
5. Receives input to control its decision-making.
6. Reports activity to other devices.
7. Can support multiple reader technologies.
8. Incorporates Flash Memory for remote upgrades or enhancements to firmware.
9. Provides communications in multiple formats to downstream panels or Host Software.

B. District Standard Configuration
1. Enclosure – UL listed Cab 4 Enclosure with internal 12VDC charge card and battery backup and external transformer. Note plug-in transformers will not be used and a hardwired consolidated transformer specified later will be used to power up to 3 controllers.
2. Components
   a. DBU – fitted with Network Interface Module for TCP/IP communications and integral RS232 communications to fall back on dial-up modem communications.
   b. (2) 4DCU.
   c. (4) I/O modules.

C. Capacities:
1. Card Readers: Standard configuration includes 8 cabled to and terminated in main controller enclosure. Controller is expandable to 16 with modular units connected to main database unit.
2. Monitor Inputs: Standard configuration includes 32 inputs in main controller, expandable to 96 when including modular controllers.
3. Relay outputs: 16 standard expandable to 32.
4. Card Holders: 20,000.
5. Elevator Control configuration allows for a single card reader connected with 32 floor control.

D. Mounting: Provide in its own enclosure as a complete UL assembly with power supply.

E. Power:
1. Source: Power is provided via unshielded twisted pair wiring from an external transformer and internal 12VDC charge card and 7.0 AMP Hour Battery.
2. Power only the controller components and card readers from control panel power supply.

3. Power all other devices including additional door furniture, locks, intrusion devices, and auxiliary relays from power supplies designated as such and specified herein.
4. DBU Battery: A low voltage battery (such as a lithium cell) shall maintain the internally stored database setup when no power is available to the controller.

F. Communications
1. TCP/IP or Dial-up Communications from 1st panel on chain to host.
2. 20 MA secure bi-directional to downstream panels in chain.
3. 20 MA to card readers.

G. Self-protection: The Controller shall have inputs to detect:
1. Power input failures.
2. Controller tampering.

H. Manufacturer: AMAG Technologies M2100.

## 2.3 MONITOR INPUT/RELAY OUTPUT BOARDS

A. General: Module that monitors inputs and provides relay outputs.

B. Capacities:
1. Monitor Inputs: 8 four-state supervision monitor points.
2. Relay Outputs: 4 Normally Open (NO) or Normally Closed (NC) Form C.

C. Mounting: Plug in (piggyback) to door control units.

D. Manufacturer: AMAG Technologies – I/O module.

## 2.4 NETWORK/COMMUNICATION INTERFACE DEVICES

A. TCP/IP 10/100BASE-TX Connection.

B. Any communications that must be achieved for the first panel other than direct connection to District WAN must be reviewed and approved by the District and the Engineer.

C. Automatic fail over to RS232 dial up communications for alarm routing to host.

D. Manufacturer: AMAG Technologies Network Interface Module.

## 2.5 CARD READERS

A. General
1. Wire readers back to the Controller directly. Do not daisy chain readers together.
2. Presenting a card to the reader shall initiate a single read. Thereafter the card must be removed from the reader's field and re-presented before it is again read by the system.
3. Coordinate specific reader types to be used below with district prior to ordering.
4. Integral LED to indicate the status of the door and an audible indicator. The LED status shall be as follows:
   a. Red steady indicates reader is powered up.
   b. Red flash after card presentation indicates card has been read but access is denied.
   c. Green Momentary indicates card is valid and access is granted.
   d. Green Steady indicates door is unlocked indefinitely on schedule.

5. Provide with an internal tamper switch that will indicate an alarm condition if an unauthorized attempt is made to disassemble the unit.
6. Provide units capable of communicating in 20 MA bi-directional supervised protocol.

B. Exterior Perimeter Mullion Readers
1. Read Range: 2.5 inches (typical).
2. Operating Voltage: 9-14 VDC.
3. Manufacturer: AMAG Technologies S830 Micro Proximity Reader, Black or best color to match mounting surface.

C. Interior Prox+Pin Command Card Readers.
1. Read Range: 5 inches (typical).
2. Operating Voltage: 9-14 VDC.
3. Additional LEDS indicating card command and alarm armed status. Card Commands programmed from system head end and software based.
4. Manufacturer: AMAG Technologies S840 Keypad Proximity, Ash Gray or best color to match mounting surface.

D. Interior Standard Prox Readers
1. Read Range: 2.5 inches (typical).
2. Operating Voltage: 9-14 VDC.
3. Manufacturer: AMAG Technologies S820 Micro Proximity Reader, Black or best color to match mounting surface.

## 2.6 REQUEST TO EXIT SENSORS (REX)

A. General
1. Mount REX detector directly to top jamb of doors above recessed contacts.
2. Aim detection pattern directly down in front of door plane to minimize pedestrian circumventing.
3. Minimize relay pulse time to 1 second and allow controller to determine bypass time.
4. Wire REX cables directly back to controller.
5. Terminate signal to REX input on controller.
6. Power REX detector from auxiliary 12VDC device power supply.

B. Manufacturer: Detection Systems DS160i, Black or best color to match mounting surface.

## 2.7 DOOR CONTACTS

A. General
1. Install door contacts flush in top jamb or side jamb of door near top corner.
2. Align magnet with door contact.
3. Report fire rated assemblies not factory prepped to general contractor to coordinate and acceptable solution.
4. Wire contact cables directly back and terminate to controller.
5. Closed-loop, 1/2" gap.

B. Manufacturer: Sentrol 1076 1" recessed contacts, mahogany; or approved equal.

## 2.8 ELECTRONIC DOOR LATCHES (Single Door)

A. General
1. Provide door with 3/8$^{th}$ inch horizontal pathway for routing wires to electronic latch.

2. Report fire rated assemblies not factory prepped to general contractor to coordinate and acceptable solution.
3. Wire Latch cables directly back and terminate to controller.

B. Manufacturer: Schlage ND80RDEU; or approved equal.

## 2.9 ELECTRONIC DOOR LATCHES (Double Door)

A. General
1. Provide door with 3/8th inch horizontal pathway for routing wires to electronic latch on normally opening door.
2. Report fire rated assemblies not factory prepped to general contractor to coordinate and acceptable solution.
3. Wire Latch cables directly back and terminate to controller.

B. Manufacturer: Schlage ND80RDEU; or approved equal.

## 2.10 ELECTRONIC DOOR LATCHES (Panic Hardware Door)

A. General
1. Provide door with 3/8th inch flex conduit pathway for routing wires to electronic panic hardware.
2. Report fire rated assemblies not factory prepped to general contractor to coordinate and acceptable solution.
3. Wire panic hardware cables directly back and terminate to controller.

B. Manufacturer: Electrified Von Duprin Panic Hardware; or approved equal.

## 2.11 GLASS BREAK DETECTOR

A. Provide digital type glass break sensor utilizing DSP technology.

B. Sensor shall be capable of being mounted on any surface either vertically or horizontally within 25' of glass surface to be protected.

C. Coordinate location with Architectural reflected ceiling plan and other devices in ceiling.

D. Connect glass break alarm signal to input modules on ACAMS panel.

E. Power glass break detector from auxiliary 12VDC device power supply.

F. Manufacturer: GE Security Round Acoustic Glassbreak 5812-RND; white; or approved equal.

## 2.12 TRANSFORMERS

A. General
1. Transformer shall convert 120/240V AC power to 12/24 Volts AC.
2. Hardwire transformer to electrical junction box (plug-in transformers are not acceptable).
3. Transformer must be rated to power three ACAMS controllers and not shared with other device power requirements.

B. Manufacturer: AMAG XFMR.

## 2.13 POWER SUPPLIES/BATTERY CHARGERS

A. Control Panel Power Supply: Integral to AMAG Controller Assembly. Connect to ACME transformer.

B. Lock/Relay Power Supplies
1. 120V hardwired input.
2. 6 AMP continuous 24VDC supply.
3. Alarm output for AC fail and low battery; connect to alarm inputs on ACAMS control panel.
4. Integral Isolation relays with 8 access control input triggers and 8 independently controlled and configured outputs.
   a. Dry outputs for triggers to PS-873 power supply at exit device doors.
   b. Wet 24VDC to low current locks.
   c. Wet 24VDC to power control relays in elevator demarcation enclosure.
5. Interconnect all card reader outputs (8) in a one to one relationship to inputs (8) on power supply.
6. Switching lock load through Access Control Panel relays is unacceptable.
7. Do not use for devices other than locks and control relays.
8. Manufacturer: Altronix AL600ULACM.

C. Device Power Supplies
1. 120V hardwired input.
2. 4 AMP continuous @ 12VDC.
3. Alarm output for AC fail and low battery; connect to alarm inputs on ACAMS control panel.
4. Do not power locks from power supply.
5. Manufacturer: Altronix AL400ULM.

## 2.14 DOOR MANAGEMENT ALARM

A. Provide door management alarms at all in/out card reader locations.

B. Alarm shall be equipped with integral Rim Cylinder and keyed to the building standard.

C. Connect door alarms directly to door management alarm.

D. Provide remote reset/shunt recycle function from card reader alarm bypass output to shunt alarm on valid card presentations.

E. Power alarm from 12 VDC auxiliary power supply at SEC.

F. Manufacturer: Designed Security Inc; Door Management Alarm ES4200.

## 2.15 EMERGENCY EXIT ALARM

A. Alarm shall be equipped with integral Rim Cylinder and keyed to the building standard.

B. Connect door contacts directly to exit alarm.

C. Power alarm from 12VDC auxiliary power supply at SEC.

D. Manufacturer: Designed Security Inc; Exit Alarm ES4300.

## 2.16 DURESS BUTTONS

A. Provide under-counter pull type duress buttons at each public service or help counters as indicated on the plans.

B. Coordinate final location for installation prior to owner to ensure they are ergonomically appropriate easily accessed with excessive travel.

C. Provide pathway and route consistent with telecom pathways to counters as well. Security and telecom cable me share the same furniture raceways if required.

D. Manufacturer: Sentrol 3040.

## 2.17 TYPE 1 PULL BOXES/JUNCTION BOXES

A. Provide 24"x24"x6.62" type 1 lockable enclosure at locations shown on plans.

B. Pull Boxes do not require back panel.

C. Elevator junction boxes require back panel and the following components fabricated to panel.
1. 24VDC low current double pole double throw form c equipment isolation relays.
2. Configure each relay for independent control of either floor select buttons Elevator 1 or hall call buttons Elevator 2 and powered from the lock power supplies located in the SEC.
3. Provide terminal strip on panel for landing outputs from relays on one side and interconnecting elevator cables on other side.
4. Provide tamper alarm in enclosures and terminate to ACAMS panel.

D. Manufacturer: Hoffman Type 1 Enclosure A-2420ALP; Panel A2420MP; Cylinder Lock Kit A-L12AR.

## 2.18 MODEM

A. Provide 56K dialup modem and connect to 1st panel in SEC.

B. Modem provides dial up communications if network is unavailable.

C. Install modem in separate communications enclosure with network outlet.

D. Manufacturer: US robotics, Black Box, Approved Equal.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. Control Equipment Installation
1. Coordinate installation of equipment with other trades to avoid unforeseen conflict.
2. Install supervisory and end of line resistors as required.
3. Interconnect all access control panels, lock power supplies and device power supplies with rigid conduit and screw cover raceway (gutter) to protect cables through out.
4. Hardwire all power supplies with electrical conduit fittings and junction boxes, plug in transformers and exposed cable is unacceptable.

5. Coordinate Network Data Drop with Telecom contractor inside access controller.
6. Coordinate IP address with District IT staff.
7. Coordinate Voice connection with District IT department.

B. Field Devices
1. Homerun all cable from field devices to control panel, utilizing J-Hangers, sleeves and risers for vertical and horizontal cable runs.
2. Provide wiremold surface mounted raceways to devices when concealment of EMT conduit is mot possible. Exception is long multiple cable pathways routing to pull boxes or homeruns.
3. Install devices as indicated on drawings.
4. Use conduit pathways and fish cable as required to final device locations including using storefront mullion as raceways.

C. Locking and ADA Hardware
1. Coordinate the installation and termination of the security cable with the installation of the electric door hardware and transfer hinge provided under Division 28.
2. Connect and configure access control system integration to ADA operator as indicated in drawings. Reconfigure if required to meet sequence of operation for door. Coordinate with door contractor for equipment terminations.

D. Elevator Integration
1. Meet with elevator contractor to review scope and delineation of scope.
2. Provide functioning relays in demarcation enclosure prior to elevator button cutover to ensure elevator will function with card readers at time of turn-up.
3. Furnish card reader to elevator contractor.
4. Coordinate the installation and termination of the card reader inside the cab and in the elevator machine room.

## 3.2 PROGRAMMING

A. Prior to the completion of construction, schedule a meeting with the Owner and the Engineer to determine the programming criteria and access to District head end. Discuss the following:
1. Door Names.
2. Device Names.
3. Alarm groups.
4. Schedules and time codes.
5. Action/responses from individual input points.
6. Action response from card and keypad commands.
7. Alarms tagged for routing ASCII data to existing alarm dialer.

B. Document the results of the meeting and perform necessary programming to achieve the Owner's requests.

C. Program the system such that reliance on a remote host for routine building operations, such as scheduled door commands and conditional events, are minimized to the greatest extent possible and decisions are made at the local building controller.

D. Program the system in a manner that minimizes the amount of time required for the users to make updates and maintain the system on a daily basis especially updates that impact card holder record updates. Nested programs, such as reader groupings used in access codes shall be used to the greatest extent possible such that single actions are required to update an entire card data population. If there is a question regarding the appropriate approach to programming, given the flexibility of most systems, contact the Engineer prior to any initial programming.

E. Program and setup all system hardware such that no additional programming other than entering new access cards, time codes, and access adding doors to existing access privilege groups is required. Programming shall include the setup of available features of the software.

**END OF SECTION**

# SECTION 28 23 00

# VIDEO SURVEILLANCE SYSTEM

## PART 1 - GENERAL

### 1.01 SUMMARY

A. General: Provide engineering, labor, materials, apparatus, tools, equipment, transportation, temporary construction, and special or occasional services as required to make a complete working video surveillance system installation, as described in this specification.

B. Section Includes:
1. CCTV Monitoring and Recording System
2. CCTV analog and IP fixed and PTZ cameras, lens, mounts, and housings
3. CCTV power supplies
4. Network video storage servers
5. Integration with ACAMS
6. Interfaces and connections to District security LAN/WAN to allow remote viewing over network

C. Products Supplied But Not Installed Under This Section:
1. None

D. Products Installed But Not Supplied Under This Section:
1. None

E. Products Specified But Not Installed Under This Section:
1. None

F. Products Furnished and Installed Under Another Section:
1. 120VAC power
2. Ethernet cable back to IDF/MDF room for IP cameras
3. Owner provided PoE switches in the IDF/MDF for CCTV connectivity via security LAN/WAN
4. Network ports for video storage servers, edge network video servers, and video monitoring workstation connectivity via security LAN/WAN

G. Related Sections:
1. Consult other Divisions; determine the extent and character of related work and properly coordinate work specified herein with that specified elsewhere to produce a complete and operable system.
2. Section 28 00 00 Basic Security Requirements: includes general project requirements, submittal formats, warranty, and installation requirements and additional sections for reference.
3. Section 28 13 00 Access Control & Alarm Monitoring System: includes product information for video integration with the ACAMS.
4. Section 28 05 13 Security System Cabling: includes product information for wire and cable needed to support the ACAMS.
5. Section 28 05 53 Security System Labeling: includes label types and formats for security devices.
6. Section 28 08 00 Security System Commissioning: includes the integrating testing/commissioning requirements for the ACAMS.
7. Section 27 15 13 Telecommunications Horizontal Cabling: includes product information for cable needed to support Video Surveillance System IP devices.

### 1.02 DEFINITIONS

A. The Definitions of Division 1 apply to the 28 00 xx sections.

B. In addition to those Definitions of Division 1, the following list of terms as used in this specification defined as follows:
   1. "NVR": Network Video Recorder
   2. "VMS": Video Management System
   3. "PTZ": Pan-Tilt-Zoom
   4. "NAS": Network Attached Storage
   5. "PoE": Power-over-Ethernet
   6. "ENVS": Edge Network Video Server

## 1.03 SYSTEM DESCRIPTION

A. Overview
   1. Refer to Division 1 and Section 28 00 00 for general description
   2. The video surveillance system is an extension to the overall security management system that includes access control and alarm monitoring (ACAMS) and mechanical keying.
   3. Provide pathways to connect camera locations to existing primary security infrastructure.
   4. Provide a fully functioning Video Surveillance System and extension of the existing network-based recording system with capacity to store recorded footage for a minimum of 30 days.
   5. Utilize existing security network for IP video transport to existing centralized VMS.

B. Video Surveillance System
   1. The video surveillance system consist of IP fixed position and pan-tilt-zoom cameras connected to Owner provided security PoE switch(es) located in MDF/IDF rooms. These connect to existing network video servers that manage and store IP video streams over the dedicated security LAN on each campus.
   2. Provide Network Video Recorder (NVR) server software on rack mount server located on existing MPOE security rack to allow for incremental growth of up to 40 more network cameras and storage space for at least 30 days for video retention.
   3. Provide appropriate number of video licenses for additional cameras connected to the AMAG system through the security LAN, AMAG ENVS devices, or existing DVRs.
   4. Coordinate network connections to video servers, additional video monitoring workstations, and IP cameras with the District's IT department prior to installation. Provide one security network connection for each device.
   5. Provide fixed CCTV cameras as indicated on the floor plans. Use megapixel cameras at exterior locations viewing large assembly size spaces or interior locations viewing large lobbies. Include environmental housing with heater and blower for cameras located outdoors.
   6. Utilize PoE switches for camera power and connection to VMS.
   7. Provide PTZ CCTV cameras as indicated on the floor plans. Include environmental housing with heater and blower for cameras located outdoors.
   8. Home run and connect exterior weather proof camera video signal and data control cable to video servers. Power cameras locally from CCTV power supplies located within 50 feet. Size power supplies accordingly for voltage loss and power demands for outdoor rated enclosures with heater and blower options included.
   9. Provide CCTV camera power supplies located in the IDF rooms adjacent to ACAMS power supplies.
   10. Provide day/night cameras in outdoor locations with low light levels.
   11. Provide appropriate lens as indicated on plans to establish correct field of view. Field verify exact lens settings on each camera for clear picture during both day and night.
   12. Provide LAN and Power-Over-Ethernet extender for IDF to camera distances greater than 270 feet. Refer to Section 280513 Security System Cabling for device information.
   13. Under the Owner's existing AMAG software maintenance agreement, upgrade global and enterprise editions of software as needed to support additional VMS features.
   14. Provide video servers with 4 analog video inputs each, local hard drive, and a network port. Locate in IDF rooms wall mounted adjacent to ACAMS equipment panels. Coordinate any rack mount video server locations with the District's ITS department prior to installation.

15. Program integration to District's AMAG access control system as follows:
    a. Program video servers for recording based on ACAMS alarm events such as door alarms or duress button activation. Recorded video will reference associated alarm information and video monitoring workstation(s) will display recorded video clip automatically.
    b. Program PTZ cameras to view preset locations upon alarm events. Review each preset location with the District and System Operators in the programming meeting.
    c. Setup IP camera's built-in video motion detection when ACAMS alarms are not available. [Setup video recorder's built-in video motion detection when ACAMS alarms are not available.] Review each location with the District during the programming meeting.
    d. Review alarm integration and workstation configuration with the District during the programming meeting. Set quality of recorded video to maximum setting at 10 frames per second minimum during an alarm condition.
16. Program storage requirements for ENVS units as follows:
    a. Store archived video for longest period of time allowable on local video server hard drive when connection to a storage server does not exist. Overwrite oldest footage and generate an alarm to a monitoring workstation when hard drive reaches maximum capacity. Long-term storage solutions are typically not provided in individual project scope.
    b. Program video server to transfer video footage to an available storage server during network off-peak hours. Coordinate schedule with District IT department.

C. Custom Device Requirements
1. Provide fiber optic media encoders and decoders for analog camera locations over 1200 feet from an IDF closet. Coordinate fiber optic cable infrastructure and allocation for security functions with ITS and telecommunications engineers.

D. Tamper Monitoring
1. Provide additional monitor input points for monitoring the following:
    a. Tamper switches located within each security equipment enclosure and wire way
    b. Supervision of power supplies and batteries

## 1.04 SUBMITTALS

A. Product Data: Submit product information for components specified herein. Refer to Section 28 00 00 for format and requirements.

B. Shop Drawings: Submit shop drawings in accordance with Division 1. Refer to Section 28 00 00 for format and additional requirements. Include the following.
1. Device placement on floor plans
2. Point-to-Point Diagrams: Include wiring, points of connection and interconnecting devices between the following:
    a. Video surveillance system, monitors, and recording equipment
    b. Devices connected to the system
    c. Miscellaneous control relays
    d. Conductors (identify conductors on the point-to-point diagrams with the same tag as the installed conductor)
3. Block Diagram/Riser Diagram: Show the video surveillance system components, conduit, wire types, and sizes between them, including cabling interties between termination hardware.
4. Custom mounting details

## 1.05 WARRANTY

A. Digital Video Recording System
1. Provide a manufacturer's warranty covering repair or replacement of defective parts for a period of three years from the date of shipment from the factory
2. Cameras and support devices

a. Provide a manufacturer's warranty covering repair or replacement of defective parts for a period of one year from the date of shipment from the factory.

## PART 2 - PRODUCTS

### 2.01 MANUFACTURERS

A. Digital Video Recording System
   1. The video surveillance recording software manufactured by Group 4 AMAG Technologies.
   2. The system must be compatible with the Districts existing AMAG headend.
   3. The video storage server hardware must be capable of handling video surveillance system software and network video.

B. IP Cameras
   1. Axis Communications
   2. Or Equal

C. Analog Cameras
   1. Pelco
   2. Panasonic

D. Power Supplies
   1. Pelco
   2. Axis
   3. Altronix

### 2.02 NETWORK VIDEO RECORDERS

A. Features
   1. Complete Network Video Recorder platform that encompasses recording video, viewing video, reviewing recorded video, and storing video for indefinite periods of time.
   2. Full control of camera selections, sequencing, and viewing modes
   3. The system simultaneously records, displays live video, and plays back video. None of the video operations interfere with each other. Live view and video playback does not interrupt the recording process.
   4. Recorders capture, digitize, and store video. Recorders may record full-time, in response to an alarm, or based on a user-defined schedule. Full-time recording refers to 24 hours per day, 7 days per week, 365 days per year.
   5. Network: Internal Ethernet card for connection to a 100/1000Base-T LAN.
   6. Video Capture: Captures camera signals from fixed cameras, PTZ cameras, low light cameras, and edge video servers. Camera signals may be color, black and white, or both.

B. Recorders
   1. Use TCP/IP network protocol to communicate with network cameras and other video servers.
   2. Video Information
      a. Store the time, date, and source of the video and be available during playback.
      b. Store for each clip video source, capture date, start time, and stop time. Source identified as either a monitor or a camera.
      c. Store alarm information in the database on the main server when the video is in response to an alarm condition.
   3. Recording Configuration
      a. Use TCP/IP network protocol to communicate to head end.
      b. Captures camera signals from fixed cameras, PTZ cameras, infrared cameras, x-ray cameras, and low light cameras. Camera signals may be color, black and white, or both.

c. Capable of simultaneously recording each camera at VGA (640x480) resolution at 30 frames per second NTSC and 1.3 megapixel (1280x1024) resolution at least 12 frames per second.

4. Video Storage
   a. Video stored in clips on the recorder's internal hard drive. As the hard drive becomes full,groom oldest clips to make room for new video.
   b. Ability to utilize a variety of network storage devices such as external disk arrays, RAID and NAS devices, and external disk drives for exporting, backup, or sharing images.
   c. Ability to modify video quality per camera with respect to recorder and server configurations, length of time video to be store.
5. Video Authentication
   a. Fingerprint each video clip through a mathematical algorithm during the video capture process. The fingerprint becomes part of the clip and used by the playback software to verify the video has not been altered.
6. Alarm recording
   a. Recording Options
      1) Alarm condition via activation of an external alarm contact.
      2) Internal video motion detection
   b. Recording programmable by camera and by time and date schedule.
   c. Allow a mix and match of continuous recording and alarm recording, based on camera input and capture card connection.
   d. Pre and post alarm recording
7. Video Motion Detection
   a. Support cameras capable of detecting activity from camera input and to initiate an alarm condition.
   b. Video motion detection areas operator selectable for each camera. If the scene changes within the alarm area, an alarm condition is initiated.
8. Viewing of both live and archived images, from multiple remote systems.
9. Remote event notification
10. Password protected via user authorization, with profiles assigned by the system administrator, and database tracking of evens.

C. NVR Hardware (verify hardware meets software requirements at time of purchase)
   1. Complete prepackaged unit containing:
      a. Processor: Intel Core 2 Quad Q9450 12MB Cache, 2.66GHz, 1333MHz FSB
      b. Memory: 4GB 800MHz (4x1GB), Dual Ranked DIMMs
      c. Hard Drive: Minimum of (4) four 750GB 7.2K RPM, SATA 3bps hard drives
      d. Provide 4TB of storage
         1) Create 40GB Microsoft OS partition override for primary hard drive
         2) Provide 300GB segment for video management software use.
      e. OS: Windows Server 2003 R2, Standard Edition SP2 with 5 CALs
      f. 24x IDE CD-RW/DVD ROM drive
      g. Network Adapter: Dual embedded gigabit Ethernet NIC
      h. Video Card: 256MB PCI express graphics card
      i. Chassis Configuration: Rack chassis with sliding rails and cable management arm
   2. Manufacturer:
      a. Dell PowerEdge 2950
      b. Or Equal

D. NVR Software
   1. Manufacturer:
      a. AMAG: Network Video Recorder Software #VID-MOD-xxx-V6. Verify quantity of IP cameras supported with hardware configuration at time of purchase.
      b. AMAG Camera Channel Licenses #VID-CAM-0xx
      c. AMAG Additional Storage Management Software# VIDEO-STORE-64-V6

## 2.03 NETWORK VIDEO SERVER

A. General
1. Network video server that encompasses recording video, viewing video, reviewing recorded video, and forwarding recorded video to larger servers storing for indefinite periods of time.
2. The video server must be compatible with the Districts existing AMAG Technologies Access Control System for remote viewing and integration with an already developed interface.
3. Up to 4 color, black-and-white, or auto-switching analog cameras connect to the video server through BNC connectors.
4. The video server shall provide RS-232, RS-485, or RS-422 communications for controlling PTZ/dome devices from various manufacturers. These devices shall be controlled through the local or remote user interface.
5. Servers capture, digitize, store, and forward video. Servers may record full-time, in response to an alarm, or based on a user-defined schedule. Full-time recording refers to 24 hours per day, 7 days per week, 365 days per year.
6. The system simultaneously records, displays live full-frame video, and plays back video through the network. None of the video operations interfere with each other. Live view and video playback through the network does not interrupt the recording process.
7. The video server shall be configurable via integrated web server.
8. The video server must include network interface for viewing, playback, configuration, and alarm management operations of the District LAN/WAN and support 10/100 Base-T operations.
9. Standard internet browser based access via Internet Explorer 5.0 or higher on Windows 98, ME, NT, 2000, or XP.

B. Servers
1. Use TCP/IP network protocol to communicate to client workstations and video archive server.
2. Integrates with AMAG ACAMS Symmetry software and multiNODE control panels at a peer to peer level.
3. Video Information
   a. Store the time, date, and source of the video and be available during playback.
   b. Store for each clip video source, capture date, start time, and stop time. Source identified as either a monitor or a camera.
   c. Store alarm information in the database on the main server when the video is in response to an alarm condition.
4. Recording Configuration
   a. Use TCP/IP network protocol to communicate to client workstations and video archive server.
   b. Captures camera signals from fixed cameras, PTZ cameras, infrared cameras, x-ray cameras, and low light cameras. Camera signals may be color, black and white, or both.
   c. Complete control over video frame rate, resolution, and compression settings on a timed and trigger basis.
5. Video Storage
   a. Video stored in clips on the server's internal hard drive. As the hard drive becomes full, generate an alarm then groom oldest clips to make room for new video.
   b. Ability to forward video stored on the server's internal hard drive to a larger video archive server through a TCP/IP network connection.
   c. Video forwarding parameters and schedule are user definable to take place at off-peak times.
   d. Ability to utilize a variety of network storage devices such as external disk arrays, RAID, and NAS devices for exporting stored video.
   e. Ability to specify per camera with respect to server configuration, length of time video is stored.
6. Alarm recording
   a. Recording Options
      1) Alarm condition in integrated ACAMS
      2) Internal video motion detection
      3) Alarm condition via activation of an external alarm contact

b. Recording programmable by camera and by time and date schedule.
c. Allow a mix and match of continuous recording and alarm recording, based on camera input and server network connections.
d. Pre and post alarm recording

7. Video Motion Detection
   a. Each video input capable of detecting activity from camera input and to initiate an alarm condition.
   b. Video motion detection areas operator selectable for each camera input. If the scene changes within the alarm area, an alarm condition is initiated.
   c. Sensitivity adjustment for video motion detection areas.
8. Viewing of both live and archived images, from multiple client workstations.
9. Video server alarm event notification such as video loss or hard drive failure to client workstations.
10. Password protected via user authorization, with profiles assigned by the system administrator, and database tracking of events through the video management software.
11. Mounting
    a. Wall mountable in a standard AMAG CAB 4 enclosure.
    b. Optional standard 19" rack mount configuration with integrated power supply.

C. Manufacturer:
1. AMAG: G4T-ENVS
2. Provide 80GB or larger hard drive available at time of purchase

## 2.04 SECURITY WORKSTATION

A. System Hardware: Document the cost of this hardware at time of bid due to price reductions and advancements in technology. Prior to placement of order, provide upgrades to the most current model as requested by the Owner up to the cost of the specified system.
1. Processor: Intel Core 2 Duo E8400 6MB Cache, 3.00GHz, 1333MHz FSB
2. Random Access Memory: 2GB minimum.
3. Mass Storage: 120 GB (7,200 RPM, 8 ms avg. seek) fixed disk drive.
4. Video Card: (2) 256MB PCI express graphics card with (2) DVI outputs each supporting up to four monitors
5. I/O Ports
   a. Mouse port
   b. 1-parallel port
   c. 2-RS232 serial ports
   d. 4-USB 2.0 ports
   e. One 10/100/1000 BASE-TX NIC
6. Input media
   a. 1.44 MB 3.5" diskette drive
   b. 48x CD/DVD-R/W drive
7. Keyboard: Enhanced 101-key with tactical feedback.
8. Mouse: Logitech 3-button mouse.
9. 20" Flat Panel LCD Monitor (two per workstation)
   a. Screen Dimension: 20 in (viewable image size)
   b. Minimum Resolution: 1600x1200 / 60Hz
   c. Image Brightness: 300cd/m2
   d. Image Contrast Ratio: 800:1

B. Software
1. Operating System: Most current version of Windows supported by the system manufacturer
2. Provide AMAG Symmetry Video Management software on client workstations used for video surveillance:

a. This application shall be installed on any Windows-based computer with a network connection to the digital video management system(s) for live and recently recorded video.
b. The client workstation viewer interface shall allow the user to simultaneously view recorded video from multiple cameras and multiple digital video management systems.
c. Multiple workstations can access the digital video management system simultaneously.
d. Cameras are viewed in a video window by dragging an icon to the window. Camera combinations are automatically saved for each video window configuration.
e. The camera name and time of video capture can be displayed using a menu option. Text position and color shall be user-configurable.
f. Cameras shall be organized in a directory tree by their name and grouped together under specific categories. The digital video management system to which they are connected should not interfere with the organization or user interface.
g. A search utility is necessary in the management software. Recorded video shall be searchable based on alarm, date, time, and camera.

3. AMAG Software: AMAG SMS Client Software (most current version)

C. UPS:
1. Provide one UPS for each workstation furnished.

## 2.05 CAMERA SYSTEM

A. General
1. Type: Color, solid-state CCD with DSP technology, unless otherwise noted
2. Power: 24 VAC/VDC
3. Imager: 1/3 inch format, unless otherwise noted
4. Lens Mount: Accept a "CS" mount auto or manual-iris lens
5. Synch: Adjustable line lock for synchronizing camera to power line. No auxiliary sync cable required.
6. Resolution: 640x480 minimum resolution, unless otherwise noted
7. Minimum Light Level: 0.1 fc imager illumination at full video, unless otherwise noted
8. Lens: Field determine, unless otherwise noted
9. Video transmission through IP signal or analog signal to IP encoder

B. Fixed IP Interior Dome Cameras
1. Complete prepackaged unit containing:
a. Superior 640x480 resolution to 1.3 megapixel image sensor quality with progressive scan
b. Resolution: 12 frames per second at 1280x1024 and 30 frames per second at 640x480
c. Video streaming: Simultaneous Motion JPEG and MPEG-4
d. Auto iris, varifocal lens of 2.8-10mm
e. Security: IP address filtering and HTTPS encryption
f. Power over Ethernet (IEEE 802.3af), Class 1
g. Connectors:
1) Ethernet 10/100 BaseT, RJ-45
2) Terminal block for alarm inputs, output, and RS-485/422
3) Power - Mini DC
h. Dome housing
2. Manufacturer:
a. AXIS #216FD-V network interior dome camera
b. AXIS #216MFD-V network interior dome megapixel camera
c. Arecont Vision #AV1300M (verify compatibility with video recording and management platform at time of purchase)
d. IQinvision IQeye511 #IQ511 V3PED1 interior dome (verify compatibility with video recording and management platform at time of purchase)
e. Or Equal
3. Accessories:

a. AXIS Drop Ceiling mount kit #5005041
b. Arecont Vision #Dome 5-I interior recessed dome
c. IQinvision enclosure "D1" option for interior ceiling
d. Or Equal

C. Fixed IP Exterior VGA Dome Cameras
1. Complete prepackaged unit containing:
a. Superior 640x480 resolution image sensor quality with progressive scan
b. Resolution: 30 frames per second at 640x480
c. Video streaming: Simultaneous Motion JPEG and MPEG-4
d. Auto iris, varifocal lens of 2.8-5.8mm
e. Security: IP address filtering and HTTPS encryption
f. Power over Ethernet (IEEE 802.3af), Class 1
g. Connectors:
1) Ethernet 10/100 BaseT, RJ-45
2) Terminal block for alarm inputs, output, and RS-485/422
3) Power - Mini DC
2. Manufacturer:
a. AXIS #225FD network exterior dome camera
b. Or Equal

D. Fixed IP Exterior Megapixel Cameras
1. Unit containing:
a. Superior 1.3 megapixel image sensor quality with progressive scan
b. Resolution: 12 frames per second minimum at 1280x1024 and 30 frames per second at 640x480
c. Video streaming: Simultaneous Motion JPEG and MPEG-4
d. Auto iris, varifocal lens of 2.8-10mm, UON
e. Security: IP address filtering and HTTPS encryption
f. Power over Ethernet (IEEE 802.3af), Class 1
g. Connectors:
1) Ethernet 10/100 BaseT, RJ-45
2) Terminal block for alarm inputs, output, and RS-485/422
3) Power - Mini DC
h. Outdoor IP66 rated housing
2. Manufacturer:
a. AXIS #223M fixed network camera
b. Arecont Vision #AV1300DN (verify compatibility with video recording and management platform at time of purchase)
c. IQinvision IQeye511 #IQ511 B1NPDV 4" Dome (verify compatibility with video recording and management platform at time of purchase)
d. Or Equal
3. Accessories:
a. AXIS ACH13HB Outdoor Housing #024889
b. Arecont Vision #Dome 4-I outdoor dome
c. IQinvision enclosure "DV" option for exterior ceiling, "D3" option for pendant with wall mount
d. Or Equal

E. PTZ IP Dome Camera
1. Provide IP PTZ camera with appropriate mount
2. Complete prepackaged unit containing:
a. 1/4" high-resolution color CCD camera & motorized zoom auto-iris lens
b. High-speed pan and tilt that is stepper motor driven (belt-driven not acceptable).
c. Integral receiver/driver

d. Color NTSC format
e. Integral 35X min optical zoom lens for exterior locations, 18x min optical zoom for interior locations
f. Exterior cameras: wide dynamic range and auto day/night switching between color and B/W
g. Motion JPEG and MPEG-4 video compression
h. Integrated heater and blower for exterior locations
i. Electronic Image Stabilizer
j. Guard tour with 50 presets minimum

3. Provide seismic support of unit attached directly to second floor deck. T-Bar hangers are acceptable provided they are dedicated to support PTZ.
4. Manufacturer:
   a. Interior – AXIS 232D+
   b. Exterior – AXIS 233D
5. Accessories:
   a. AXIS Pendant Dome Housing #25733, with integrated heater and blower

F. Fixed Analog Camera
1. Provide ceiling flush mounted integrated dome/camera/lens packages.
2. Camera must provide 480 Lines of resolution minimum.
3. Minimum Illumination level of 2.4 Lux (0.24 fc) for indoor, 0.16 Lux (0.016 fc) for outdoor B/W
4. Provide integral variable focus lens (3.8-8.0 mm) for field adjustments as required
5. Lens equipped with auto iris
6. Vandal proof enclosure
7. Exterior cameras: wide dynamic range and automatic day/night switching between color and B/W
8. Manufacturer:
   a. Interior Dome: Panasonic WV-CW224 Series
   b. Exterior Dome: WV-CW484 Series w/ WV-CW4H Heater Unit

G. Pan/Tilt/Zoom Dome
1. Provide PTZ with appropriate mount
2. Complete prepackaged unit containing:
   a. 1/4” high-resolution color CCD camera & motorized zoom auto-iris lens
   b. High-speed pan and tilt that is stepper motor driven (belt-driven not acceptable).
   c. Integral receiver/driver
   d. Color NTSC format
   e. Integral 22X min optical zoom lens
   f. Internal AC Line lock for auto syncing
   g. Exterior cameras: wide dynamic range and auto day/night switching between color and B/W
   h. Integrated heater and blower for exterior locations
3. Connect PTZ data directly to video server for on screen PTZ control.
4. Provide seismic support of unit attached directly to second floor deck. T-Bar hangers are acceptable provided they are dedicated to support PTZ.
5. Manufacturer:
   a. Pelco Spectra IV SE Series Dome

## 2.06 CAMERA LENSES

A. General
1. Built from the finest optics available for use on a CCTV surveillance type camera.
2. Contain integral intraspot filters
3. Format to match CCD imager
4. Variable focus, refer to plans for approximate range of lens
5. Auto-iris connector coordinated with the camera type (i.e., 4-pin vs. 6-pin)
6. CS type mount
7. Manufacturer:

a. Pelco
   1) #13VDIR7.5-50 - 1/3" CS-Mount 7.5-50mm Day Night
   2) #13VD1-3 - 1/3" CS-Mount 1.6-3.4mm Wide Angle
b. Panasonic
   1) #PLZ15/33 - 1/3" CS-Mount 15-50mm, F=1.5
   2) #PLA22T3DN - 1/3" CS-Mount 2.2mm, F=1.2 Wide Angle
c. Rainbow
d. Sony
e. Or Equal

## 2.07 CAMERA MOUNTS & HOUSINGS

A. Exterior Dome
   1. AXIS ACH13HB Outdoor Housing #024889
   2. Arecont Vision, see Camera Systems for options
   3. IQinvision enclosure, see Camera Systems for options
   4. Or Equal
   5. Housing: Integrated heater and blower

B. Wall Mounted
   1. Mount: Pelco SWM Series
   2. Arecont Vision, see Camera Systems for options
   3. IQinvision enclosure, see Camera Systems for options
   4. Mount: AXIS #25736 Gooseneck

C. Parapet
   1. Mount: Pelco #PP350 / PP351
   2. Mount: AXIS #25738
   3. Housing: Integrated heater and blower

## 2.08 POWER SUPPLIES/BATTERY CHARGERS

A. CCTV System Power Supplies
   1. 120 VAC input to 24 VAC output, continuous current, fully supervised power supplies for power to cameras.
   2. Provide a separate fused connection to power supply per camera.
   3. Interior Fixed or PTZ Camera
      a. Manufacturer: Pelco #MSC-16-10SB UL listed power supply/batter charger for indoor use
      b. Altronix
      c. Or Equal
   4. Exterior PTZ Camera
      a. Pelco #WCS 1-4 NEMA4X/IP66 rated for outdoor use
      b. AXIS #5000-001 24VAC Outdoor power supply
      c. Altronix
      d. Or Equal

B. Video Server Power Supplies
   1. 120V hardwired input.
   2. 6 AMP continuous @ 12VDC.
   3. Alarm output for AC fail and low battery; connect to alarm inputs on ACAMS control panel.
   4. Do not power locks from power supply
   5. Manufacturer: Altronix AL600ULX

## 2.09 CCTV FIBER CONVERTERS

A. Wall Mounted
   1. Transmit full color video in real time in NTSC, PAL or SECAM formats.
   2. Support the transmission RS-232 and RS-422 data.
   3. Utilize AGC (automatic gain control) circuitry.
   4. No in-field electrical or optical adjustments or in-line attenuators.
   5. Use frequency modulation of the optical signal to transmit the video and data signals.
   6. If video and data transmitted simultaneously on one fiber, utilize an integrated WDM for increased stability and reliability of system performance.
   7. Provide power, data transmit, video input, and AGC (automatic gain control) detect status indicating LED's for monitoring proper system operation.

B. Manufacturer:
   a. Fiber Options
   b. International Fiber Systems
   c. Pelco Fiber
   d. Or Equal

## 2.10 CCTV LIGHTNING PROTECTORS

A. Data Line Protectors
   1. Provide on data lines serving exterior IP cameras.
   2. Manufacturer:
      a. PolyPhaser Corp # NX4-60-IG
      b. DITEK
      c. Or Equal

B. Video Line Coaxial Cable Protectors
   1. Provide on coaxial cables serving exterior cameras.
   2. Manufacturer:
      a. PolyPhaser Corp #IS-75BB/1.5
      b. DITEK
      c. Or Equal

C. Power Line Protectors
   1. Provide on power lines serving exterior cameras.
   2. Manufacturer:
      a. PolyPhaser Corp #IS-SPTV
      b. DITEK
      c. Or Equal

D. PTZ Data Line Protectors
   1. Provide on data lines serving exterior PTZ cameras.
   2. Manufacturer:
      a. PolyPhaser Corp #IS-DPHSD
      b. DITEK
      c. Or Equal

# PART 3 - EXECUTION

## 3.01 INSTALLATION

A. CCTV Cameras
   1. Provide outdoor housing and mounts for exterior cameras.

2. Field determine exact placement of cameras to ensure complete coverage.
3. Coordinate location with obstructions such as columns or exceedingly high shelving units to avoid concealment opportunity.
4. Field determine fixed camera lens size to ensure complete coverage. Refer to plans for lens selection starting point.
5. Route watertight flex from junction box to camera housing from below on exterior cameras.
6. Provide 25 foot cable loop at PTZ location for relocating unit if required post installation
7. Provide 12 foot cable loop at interior camera locations installed in accessible ceiling location for future Owner relocation of unit if required post installation
8. Coordinate Network Data Drop with Telecom contractor for each IP Camera.
9. Coordinate camera IP address with District IT staff.
10. Coordinate programming of IP cameras into existing video surveillance head end with District and Districts contracted AMAG programmer.

B. Exterior Site Cameras
   1. Installation requirements under paragraph A, CCTV Cameras still apply.
   2. Provide NEMA 4 enclosure located in close proximity to the camera(s) with 120VAC power.
      a. Install near base of pole for pole-mounted locations.
      b. Install in nearby accessible ceiling below for roof mount cameras.
   3. Route camera cable to NEMA box and terminate.
   4. Provide waterproofing material and required gaskets in order to maintain roofing system warranty. Verify installation does not void roofing warranty.
   5. Provide lightning protection on cameras located on roof tops and parapets.

C. CCTV Power supplies
   1. Do not combine with Access Control & Alarm Monitoring System power supplies.
   2. Locate power according to security drawings.

D. Surge Protection
   1. Provide surge protection for video, power, and control cable on exterior cameras.
   2. Provide protective device at the camera and encoder/recorder device.

E. Network Digital Recording System
   1. Rack mount NVRs next to existing units on dedicated security rack.
   2. Coordinate equipment rack location with District IT department.

F. Edge Network Video Servers
   1. Wall mount near ACAMS security equipment hub in AMAG CABx enclosure.
   2. Utilize power from ACAMS controller for video servers whenever possible.
   3. Coordinate Network Data Drop with Telecom contractor for each video server.
   4. Coordinate IP address with District IT staff.

G. Pathways
   1. Provide conduit and back boxes to devices located on walls and inaccessible ceilings.
   2. Route device conduit back to security equipment hub.
   3. Provide back boxes for all devices installed in ceiling and support brackets that span T-Bar grid.
   4. Route cable on dedicated J-hanger runs attached to structure above. Do not attach cable to ceiling grid hangers.
   5. Coordinate fiber optic cable requirements with telecommunications.
   6. Coordinate joint trenching with telecommunications and/or electrical for site pathways.

## 3.02 PROGRAMMING AND TRAINING

A. Prior to the completion of construction schedule a meeting with the Owner, Engineer, and Owner's AMAG programmer to determine the programming criteria. Discuss the following:
   1. Camera naming

2. PTZ Presets
3. Schedules and recording parameters including quality and frame rate (including video motion detection)
4. ACAMS alarm and event integration requirements for workstation pop-ups and recording.
5. Video archiving schedule
6. Live viewing requirements
7. AMAG workstation user levels for defining which levels have access to specific ACAMS and video surveillance features

B. Document the results of the meeting and perform necessary programming to achieve the Owner's requests.

C. Setup and program the cameras such that no additional programming required. Programming at the head end performed by Owner's AMAG programmer.

D. Use the camera naming convention agreed upon in the programming meeting when programming point names into the system.

E. In addition to training requirements indicated in Section 28 08 00, provide 2 hours of training on all programming requirements listed above. Provide training as required to give users the ability to administer and troubleshoot system errors.

## 3.03 TESTING

A. Commission the video surveillance system in accordance with Section 28 08 00.

END OF SECTION

**SECTION 28 31 00**
**FIRE DETECTION AND ALARM SYSTEM**

## PART 1-GENERAL REQUIREMENTS

### 1.01 SCOPE

A. This Section describes a Protected Premises Fire Detection system for the following San Mateo County Community College District sites: Caňada College, College of San Mateo and Skyline College. Modifications to the existing fire alarm system shall provide evacuation alarm tone signaling using horns to sound the alarm signals and ADA-compliant strobe notification devices for visual notification. The system shall be intelligent device addressable, analog detecting, low voltage and modular, with digital communication techniques, in full compliance with all applicable codes and standards. The system provided shall have a Fire Alarm Control Panel (FACP) and field devices as indicated on the DSA-approved drawings.

B. The features and capacities described in this specification are a requirement for this project and shall be furnished by the successful contractor. The District has determined that the Siemens MXL system, supplied and installed by Siemens Building Technologies, Hayward, CA (contact Kelly Rogers: 510-783-6000), is the District standard, no equal. The system as described in this specification and as shown on the drawings shall be installed, programmed, tested, and delivered to the owner in fully operational condition. The system shall include all required hardware, software, raceways and interconnecting wiring to accomplish the requirements of this specification and the contract drawings, whether or not specifically itemized herein. The system shall consist of, but not be limited to, the following:

1. Fire Alarm Control Panel (FACP)
2. Fire Alarm Remote Annunciator (FAAP), as indicated on the drawings
3. Booster Power Supplies, as required, for notification devices
4. Addressable Manual Fire Alarm Pull Stations
5. Addressable Analog Smoke Detectors
6. Addressable Area Heat Detectors
7. Addressable Analog Duct Smoke Detectors
8. Addressable Intelligent Interface Modules
9. Audible and Visual Notification Appliances

C. Non-addressable alarm initiating, supervisory and status monitored devices shall be integrated into the fire alarm system, as applicable, via an addressable intelligent interface module, as indicated on the drawings:

1. Sprinkler Water Flow Alarm (alarm initiating)
2. Sprinkler Valve Tamper Switch (supervisory)
3. PIV, OS&Y
4. Kitchen Ansul Systems
5. Security Interface
6. Magnetic hold-opens

D. Connections to existing elevator control panels (by others) and providing the necessary modules for elevator recall and shunt trip functionality.

E. Audible/visual notification appliances and communicating devices to be controlled by the FACP:

1. Horns
2. Strobe Lights
3. Combination Horn/Strobes
4. Bells

F. Connect system to the existing campus MXL network system such that all status changes are transmitted to the Main Campus FACP.

G. DSA and local requirements shall be adhered to with regard to submitting specifications, wiring diagrams, shop drawings and plans. Responsibility for furnishing the quantities of copies in digital format and/or hard copy, as directed by contract requirements, shall be included as part of the work of this section.

**1.02 RELATED SECTIONS, RELATED WORK AND EXISTING CONDITIONS**

**A. RELATED SECTIONS**

1. Section 21 00 00 Basic Fire Protection
2. Section 01 32 19 Submittal Procedures
3. Division 01 General Requirements

**B. RELATED WORK**

1. The contractor shall coordinate work described within this section with all related trades and shall relay all necessary coordination information to the System Supplier in a timely manner such that proper coordination shall take place. Work and/or equipment provided in other sections and related to the fire alarm system shall include, but not be limited to:
   a. Mechanical Coordination: Sprinkler water flow alarm and valve tamper switches to be provided and installed by the fire protection sprinkler contractor, if a part of this project. See Division 22. They shall be wired and connected to the fire alarm system monitor modules by the contractor.
   b. Mechanical Coordination: Duct Smoke Detectors shall be provided and wired under this Section and installed under the mechanical section as shown on the fire alarm system drawings.
   c. Security Interface, if required.
   d. Coordinate with all other trade contractors for the mounting of and/or interfacing with any and all other fire alarm system related devices.

**C. EXISTING CONDITIONS**

1. This project consists of modifying the existing fire alarm system within the existing building. The contractor shall visit the site to determine and verify all existing conditions. Existing conditions that would, in the contractor's opinion, prohibit or greatly delay construction progress shall be brought to the Architect and Engineer's attention in writing in a timely manner.
2. No additional compensation shall be permitted for variations due to accessible field conditions that would affect the installation of the fire alarm system.

**1.03 REFERENCES - APPLICABLE LISTINGS, CODES, STANDARDS, DOCUMENTS**

**A. STANDARDS AND CODES**

1. All equipment shall be installed and comply with the current adopted provisions of the following codes and standards.
2. All equipment shall be Underwriters' Laboratories (UL), Inc. listed for its intended use. At a minimum, the following standards shall apply:

   a. UL 268 and 268A - Smoke Detectors for Fire Protective Signaling Systems
   b. UL 346 – Water-Flow Indicators for Fire Protective Signaling Systems.
   c. UL 464 - Audible Signaling Appliances.
   d. UL 864 - Control Units for Fire Protective Signaling Systems.
   e. UL 1481 - Power Supplies for Fire Protective Signaling Systems.
   f. UL 1971 - Signaling Devices for the Hearing-Impaired.

3. National Fire Protection Association (NFPA) standards:

a. NFPA No. 13 - 1999 Edition - Sprinkler Alarm and Supervision.
b. NFPA No. 70 National Electrical Code.
c. NFPA No. 72 National Fire Alarm Code.
d. NFPA No. 90A Installation of Air Conditioning & Ventilating Systems.
e. NFPA No. 101 Life Safety Code.

4. All raceways and wiring shall be installed in compliance with NFPA Standard 70 (National Electrical Code - Article 760) with applicable California amendments. Codes shall be implicitly followed, in particular, with regard to material type and quality, circuitry extensions from and connections to outlet and junction boxes, panel boards and similar appurtenances.

5. The fire alarm system and its installation shall comply with all applicable requirements of the Americans with Disabilities Act of 1992.

6. The fire alarm system and its installation shall comply with DSA and all other local codes and authorities having jurisdiction, including but not limited to, San Mateo County Community College District's engineering design standards and guidelines.

**1.05 SYSTEM DESCRIPTION**

A. The system shall operate as an integrated, multiplexed, protected premises fire alarm control system tied into the existing campus network system.

B. Changes in the status of monitored points shall be detected by the microprocessor based fire alarm control panel and shall report any change in status to the Main Campus Fire Alarm System utilizing master-slave networking protocol.

C. Sensor "dirty" and "excessively dirty" trouble conditions shall report automatically.

D. Devices shall be listed by UL for sensitivity testing by means of the portable programmer/tester or by readout from the control panel. Each addressable device address shall be set electronically, devices requiring dipswitch settings, rotary switch settings, staples or jumper settings are not acceptable.

E. Smoke detectors shall alarm at their programmed sensitivity settings and shall not revert to a common default setting when their operating system segment is in the fail safe degrade mode.

F. System shall individually identify each addressable initiating device and other addressable monitor functions using multiplexing interfacing techniques.

G. System shall be capable of operating each alarm notification appliance, and other control functions, using multiplexing techniques.

H. Life safety alarm function programs shall perform automatically upon system alarm actuation. In addition, control points may be operated manually at any time by the attendant through appropriate keyboard commands. The FACP shall also provide integral programmable function control switches to allow personnel to manually operate specific pre-programmed control output functions, as required.

**1.06 QUALITY ASSURANCE**

A. It is the intent of these specifications to provide a complete fire alarm system that complies in all respects with the requirements of all applicable codes and standards. Equipment, materials, software, installation practices, etc. that do not meet these requirements or do not meet the performance standards herein specified shall not be acceptable.

B. The equipment furnished under this specification shall be that of the specified manufacturer, no equal. All information herein is intended to establish minimum standards of performance, quality and

construction, and is based upon the Siemens MXL addressable analog equipment designed and manufactured by Siemens Building Technologies, Inc. Catalog and model numbers are specified herein and indicate the materials as well as the operating features required. It is not the intent of these specifications to eliminate competitive installation proposals, only to standardize the District's Fire Life Safety Systems.

C. Before commencing work the fire protection contractor shall submit data showing that contractor has successfully installed fire alarm systems of the same scope, type and design as specified. The contractor shall also include the names and locations of at least three installations where such systems have performed satisfactorily for the preceding 18 months.

1. The contractor shall submit copies of all required Licenses and Bonds as required by the State.
2. The system supplier shall employ on staff a minimum of one NICET level 4 personnel or a professional engineer, registered in the State of California.
3. Installing contractors unable to comply with the provisions of 1.06 shall present proof of engaging the services of a subcontractor qualified to furnish the required services.

D. Provide the services of a representative or technician from Siemens Building Technologies. The representative or technician is to be certified and experienced in the installation and operation of the type of system specified. The representative shall be licensed in the State, if required by law. The fire alarm contractor shall supervise installation (duct detector locations are to be determined by the mechanical contractor). The system supplier shall provide all software programming, software documentation, system adjustments, preliminary testing, final testing and certification of the system. The fire alarm supplier shall also be required to provide a 4 hour operational instruction to the owner's personnel.

E. All fire alarm system equipment furnished under this specification shall be UL listed, under the appropriate category, as the product of a single manufacturer. All control equipment shall be listed under UL as a single control unit. The manufacturer shall have been engaged in the production of this type of equipment for at least ten (10) years and have a fully equipped service organization capable of responding within 48 hours from the initial contact for warranty or regular service work. Emergency and/or off hours calls shall be responded to within 4 hours of initial contact, seven days a week.

F. Prior to bid submittal, per Document 00 11 19 Instructions to Bidders, contractor shall state what, if any, specific points of the proposed system's operation or the equipment's quality differ in any way from this specification by submission of a complete technical proposal to include supporting literature and drawings. Only those departures from these specifications, submitted in writing per the requirements of Document 00 11 19 Instructions to Bidders, shall be considered by the engineer. Failure to submit all departures from these specifications in compliance with Document 00 11 19 Instructions to Bidders, and to receive approval for such departures, shall be cause for summary rejection of any submittal documents where unapproved departures are discovered.

G. Should conflicts arise between project drawings and/or these specifications, regarding design, quantities of devices or circuits, the higher standard and/or quantity and/or cost shall be considered correct.

H. It is the contractor's responsibility to submit acceptable equipment for review by the engineer. The contractor shall bear all liability for damages arising from his failure to submit equipment that meets these specifications, including, but not limited to, any penalties for failure to meet construction deadline.

I. Final determination of compliance with these specifications shall rest with the Engineer of Record, who, at its discretion, may require proof of performance at the cost of the contractor. Required proof may include, but shall not be limited to, expense paid visits by representatives of the owner and engineer to sites where identical equipment is installed and providing beneficial use.

**1.07 SUBMITTAL REQUIREMENTS**

A. Prior to the start of work, the contractor shall provide a complete and comprehensive submittal for review by the engineer. These are to describe the proposed system and its equipment. Failure to provide a complete submittal shall be grounds for summary rejection of any incomplete submittal documentation. District reserves the right to deduct monies from payments due Contractor to cover District and Architect/Engineer's additional costs of review beyond the second submission. The complete submittal shall include, but not be limited to, all of the following material:

1. Power Calculations

    a. Battery capacity calculations shall be a minimum of 125% of the calculated requirement.
    b. Supervisory power requirements for all equipment.
    c. Alarm power requirements for all equipment.
    d. Power supply rating justification showing power requirements for each of the system power supplies. Power supplies shall be sized to furnish the total connected load in a worst case condition plus 25% spare capacity.
    e. Voltage-drop calculations for wiring runs demonstrating worst-case condition.

2. Complete manufacturers catalog data including supervisory power usage, alarm power usage, physical dimensions, finish and mounting requirements.

3. Complete drawings covering the following shall be submitted by the contractor for the proposed system. Floor plans in the current AutoCAD version showing the locations of all equipment and raceways, conductor counts with type and size.

4. A complete proposed system database including a description of all logic strings, control by event programming and point identification labels on a unique CD-ROM and in a formatted printed form, as required for off site editing, shall be submitted for evaluation by the owner.

    a. The program shall include all required interactive control functions between the local network systems and the methods for implementing these actions.

5. Provide the address, telephone number, and contact person(s) of the manufacturer's local service facility for normal and off-hour warranty issues.

6. Provide a fire alarm system function matrix. Matrix shall illustrate alarm output events in association with initiating devices input events. Matrix shall represent a summary of the installed system alarm, supervisory and trouble functions. (See Appendix-A NFPA-72 for minimum matrix requirements - A-7-5.2.2 (9) 1999).

7. For each system control and/or power panel, provide panel ampere loading during both normal and alarm modes, with time calculations to substantiate compliance with battery back-up power requirements (battery Ampere-Hour capacity), described elsewhere in these specifications.

8. For each system control panel, provide written schedule of active and spare addresses provided on each addressable circuit to substantiate compliance with circuit usage/spare requirements, described elsewhere in these specifications.

9. For each system control panel and system transponder notification appliance circuit, provide proof of spare capability in amperes available for future use, if needed.

10. Provide manufacture's printed product data, catalog pages and descriptions of any special installation requirements and/or procedures. Drawings depicting any special physical installation requirements shall show physical plans, elevations, all dimensions, conduit entry, minimum access clearances and any other details required.

11. Provide shop drawings as follows:
    a. Drawing or catalog page showing actual dimensions of the main FACP.
    b. Drawing(s) or catalog page(s) showing actual dimensions of any additional system control panels and/or battery cabinets.
    c. Drawing or catalog page showing actual dimensions of the Remote Annunciator.
    d. Single line riser diagram showing, all equipment, all connections and number and size of all conductors and conduits.
    e. Provide samples of various items when so requested by the Architect/Engineer.

**PART 2 - SYSTEM OPERATION**

**2.01 BASIC SYSTEM EQUIPMENT, CIRCUITING, ADDRESSING AND OPERATING CAPABILITIES**

**A. GENERAL**

1. The FACP shall communicate via an RS-485 Carrier Sense, Multiple Access, Collision Detect protocol, also known as CSMA/CD or an ETHERNET type topology.

2. The FACP shall provide NFPA 72, Style 4 (Class B) analog signaling line circuits. Each loop card shall communicate with and receive alarms from up to 120 points, consisting of a maximum of sixty intelligent analog alarm initiating and sixty intelligent controllable output devices. Circuits shall be configured with loop isolators and wired in a manner that prevents a catastrophic wiring event on a floor from affecting the performance of other floors.

3. Remote Annunciator (Siemens RCC Series): LCD type with two lines of 40 characters each. The Remote Annunciator shall communicate to the FACP on one #16 TSP and derive power from the FACP over a pair of #14 AWG conductors. It shall be possible to Acknowledge general "ALARM", "TROUBLE", and "SUPERVISORY" conditions from the Remote Annunciator using a key. Each Remote Annunciator must be housed in a lockable box. NEMA rated boxes are required for any locations, interior or exterior, where adverse weather or high humidity conditions occur. Mount Remote Annunciator(s) as indicated on the drawings, at a height where reasonable viewing is possible by the responding fire authority. Obtain approval of the specific location from the Architect and/or Engineer of Record prior to mounting the Annunciator.

4. System power supplies, including necessary Booster Power Supplies, transformers rectifiers, regulators, filters and surge protection required for system operation, with the capacity to power the system in a worst case condition with all devices in alarm and all local indicating appliances active without exceeding the listed ratings. Provide adequate notification appliance Booster Power Supplies so as to allow for a minimum of 20% spare capacity on each NAC.

    a. System primary power: Primary power for the FACP and the secondary power battery chargers shall be obtained from a dedicated emergency power circuit. Circuit breakers shall be fitted with a suitable guard, requiring removal of a screw to open, and used only for fire alarm. Each circuit used for fire alarm purposes shall be permanently labeled for function.
    b. Secondary power supply: Provide sealed gelled electrolyte batteries as the secondary power supply for all fire alarm functions. The battery supply shall be calculated to operate loads in a supervisory mode for twenty-four (24) hours no primary power applied and after that time, operate in alarm mode for five (5) minutes. Batteries shall be sized at 125% of the calculated size to compensate for deterioration and aging during the battery life cycle. Battery calculations shall be submitted to justify the battery size.

5. The system 16 bit core processor shall incorporate an internal operating system to process incoming alarm signals and issue output commands required as a result of the alarm reception, by system programming or by manual commands. All system processors shall be supervised by individual watchdog circuitry furnishing automatic restart after loss of activity. Systems with single watchdog circuits for all processors shall not be acceptable unless supplied with a "hot" standby CPU. Digital

communication capabilities required for the control panel to communicate with remote annunciators, input/output drivers and displays shall be provided.

6. Manual Addressable Pull Stations (Siemens MSI-10B) shall be the single action type, unless specifically noted otherwise by these specifications or on project drawings, and listed by Underwriters' Laboratories, Inc. The intelligent manual fire station shall operate on any addressable detection circuit. It shall be red in color. Manual fire stations shall be individually annunciated on the control panel. Mounting height shall be 48" inches to the manual station actuation handle from the finished floor.

7. Intelligent/analog smoke detectors (Siemens FP-11) shall be photoelectric and listed by Underwriters' Laboratories, Inc. The detector shall contain a long life light emitting diode (LED) as its light source, and photo diode as a light receiver. An automatic gain control circuit shall be compensating for detector aging and dirt accumulation. The smoke detector shall be a plug-in twist/lock unit that allows for easy connection to its mounting base. Each smoke detector, when activated, shall have a flashing tri-color LED alarm indicator that shall indicate red for alarm, yellow for trouble and green for normal operational mode. Application Specific Detection environmental settings shall be programmed as directed by the engineer. System programming shall provide multiple output functions from a single initiating multi-criteria smoke detector. This capability shall mean a separate alarm event output for smoke alarm and a separate alarm output function for thermal alarm from a single analog initiating address device. Systems not capable of providing this design requirement shall provide alternate programmable logic accomplishing design performance, acceptable to the Engineer of Record.

   a. It shall be possible to adjust and/or electronically measure the sensitivity of each individual intelligent analog smoke sensor from the control panel. Relative sensitivity or manual test methods, which check the smoke sensor at the maximum allowable obscuration, will not be considered as being equivalent.

   b. Smoke detectors shall alarm at their programmed sensitivity settings and shall not revert to a common default setting when their operating system segment is in the fail safe degrade mode.

8. Intelligent/Analog Duct Smoke Detector (Siemens FP-11/AD2-XHR, or ILP-1/AD-3ILP for rooftop applications) shall be photoelectric and listed by Underwriters' Laboratories, Inc. The detector shall contain a long life light emitting diode (LED) as its light source, and photo diode as a light receiver. An automatic gain control circuit shall be compensating for detector aging and dirt accumulation. The smoke detector shall be a plug-in twist/lock unit that allows for easy connection to its mounting base. Each smoke detector, when activated, shall have a flashing tri-color LED alarm indicator that shall indicate red for alarm, yellow for trouble and green for normal operational mode. Application Specific Detection environmental settings shall be programmed as directed by the Engineer. System programming shall provide multiple out-put functions from a single initiating multi-criteria smoke detector. This capability shall mean a separate alarm event output for smoke alarm and a separate alarm output function for thermal alarm from a single analog initiating address device. Systems not capable of providing this design requirement shall provide alternate programmable logic accomplishing design performance, acceptable to the Engineer of Record.

   a. It shall be possible to adjust and/or electronically measure the sensitivity of each individual intelligent analog smoke sensor from the control panel. Relative sensitivity or manual test methods, which check the smoke sensor at the maximum allowable obscuration, will not be considered as being equivalent.

   b. Smoke detectors shall alarm at their programmed sensitivity settings and shall not revert to a common default setting when their operating system segment is in the fail safe degrade mode.

   c. Coordinate sampling tube sizing with mechanical ducting requirements prior to shipping.

9. Heat detectors (Siemens FPT-11) shall be 135° F fixed temperature or fixed temperature/rate of rise and be listed by Underwriters' Laboratories, Inc. Rate-of-rise alarm threshold rate shall be 15° F per minute with a maximum coverage area of 2,500 sq. ft. Activation of the rate-of-rise heat detector shall

be self-restoring. All detectors shall be addressable and have a white finish. The thermal detectors shall be individually annunciated on the control panel. Each heat detector, when activated, shall have a flashing tri-color LED alarm indicator that shall indicate red for alarm, yellow for trouble and green for normal operational mode.

10. High temperature heat detectors (Siemens DT-200R) shall be conventional 200° R fixed temperature/rate compensated and listed by Underwriters' Laboratories, Inc. The detector shall have a maximum coverage area of 2,500 sq. ft. Upon activation, the detector shall latch in alarm until reset at the main fire control panel and be self-restoring. The detector shall be individually annunciated at the control panel by means of interfacing with a remote addressable monitor module (TRI Series) or an addressable conventional zone module (CZM-4). The detector's interface module address shall be set by electronic means only, no mechanical means such as programming pins, dip-switches or rotary dials shall be used.

11. Interface modules (Siemens TRI Series) shall be intelligent and listed by Underwriters' Laboratories, Inc. The unit shall incorporate a custom microprocessor based integrated circuit that provides communication with main fire control panel. The interface module shall supervise and monitor normally open or normally closed dry contacts and report their status to the control panel. The intelligent interface module shall be used to uniquely identify field devices (contacts) such as kitchen ansul, suppression system, water flow switches, tamper switches, OS&Y valves or as directed by these specifications and project drawings.

12. Intelligent interface modules (TRI-R) shall also be used when remote relays are required for system control functions, such as, but not limited to, fan shut down, door holder trip and elevator recall and shunt trip functions. Relay dry contacts shall be rated at 4 AMPS, 120 VAC resistive or 30 VDC resistive and contacts shall be Form "C" type.

13. The MXL and Booster Power Supplies shall provide NFPA 72, Style Y, two-wire (Class B), notification appliance circuits.

14. Horns (Wheelock AH Series) shall be installed as shown on the drawings in accordance with the requirements of the UL 1971 standard and NFPA 72. Provide UL listed weatherproof units and their required back boxes where shown on the drawings.

15. Horn Strobes (Wheelock Z-Series) shall be installed as shown on the drawings in accordance with the requirements of the UL 1971 standard and NFPA 72. Provide UL listed weatherproof units and their required back boxes where shown on the drawings. See Strobe requirements below.

16. Strobes (Wheelock Z-Series) shall be installed as shown on the drawings in accordance with the requirements of the UL 1971 standard and NFPA 72. Where multiple visual notification appliances can be seen from any location, circuitry shall be incorporated for the synchronization of flash rate. Strobes shall be of the latest compatible Siemens appliances. See DSA approved drawings for device quantities and locations. Provide UL listed weatherproof units and their required back boxes where shown on the drawings.

    a. Strobes shall produce a flash rate of one (1) flash per second minimum over the listed input voltage (20VDC - 31VDC) range.
    b. Strobes shall incorporate a Xenon flashtube enclosed in a rugged Lexan lens or equivalent with solid state circuitry.
    c. Strobe intensity shall be rated per UL 1971 for 15/75, 30/75, 60/75, 75 or 110 Candela. Dual listing strobes of 15/75 intensity for UL 1971/near-axis requirements shall be used where acceptable.
    d. Strobes shall be available for semi-flush or surface mounting and in conjunction with audible appliances as required.

17. Magnetic Door Hold-Opens (Rixen FM-998) shall be of the wall mount type and capable of operating at three voltages, 120VAC, 24VDC AND 24VAC, shall be provided under this section. They shall operate

using local 24VDC power. The power shall be intercepted by a fire alarm system addressable control module or a relay base detector in order to interrupt the circuit so that the door closes in a fail-safe manner. See DSA approved drawings for device quantities and locations.

18. Software and firmware control:

    a. All software and firmware provided with a fire alarm system shall be listed for use with the fire alarm control unit.
    b. A record of installed software and firmware version numbers shall be maintained at the location of the fire alarm control unit.
    c. All software and firmware shall be protected from unauthorized changes through the use of "access levels."

**B. SYSTEM ALARM OPERATION**

1. Activation of any addressable manual fire pull box, area smoke detector, heat detector or waterflow switch shall result in, at a minimum, the following functions and indications:

    a. Activate “ALARM” status change at the local FACP and annunciate on its LCD display, indicating device address, device type, device location, time and date.
    b. Indicate “ALARM” status change at the respective building Remote Annunciator indicating device address, device type, device location, time and date
    c. Activate General “ALARM” status change at the Off-Site Monitoring Station, through the Campus Network System.
    d. Activate emergency evacuation audible and visual notification appliances within the associated building(s).
    e. Annunciate “ALARM” status change at the On-site Main Campus Fire Alarm Control Panel location.
    f. Record event in the non-volatile system historical log.
    g. Record event system status change on the Main Campus Printer.

2. Elevator Recall:
    a. Activation of smoke detector in an Elevator Lobby (other than the Lobby designated “Primary Recall Floor) Machine Room or Elevator Shaft shall cause the associated elevator(s) to be recalled to the designated Primary Recall Floor.
    b. Activation of the Lobby Smoke detector on the designated Primary Recall Floor shall cause the associated elevators to be recalled to the designated Secondary Recall Floor.
    c. Activation of any Elevator Machine Room heat detector shall shunt trip the respective elevator main breaker.

**C. SYSTEM SUPERVISORY FUNCTIONS**

1. Activation of any Supervisory circuit, (i.e.; duct detector, supervised fire sprinkler valve closure, fire suppression system air pressure abnormal, low temperature, fire pump trouble, emergency fuel tank level alarm, as applicable to this project), shall cause the following actions and indications:

    a. Activate “SUPERVISORY” status change at the FACP and annunciate on its LCD display, indicating device address, device type, device location, time and date
    b. Indicate “SUPERVISORY” status change at the respective building Remote Annunciator indicating device address, device type, device location, time and date
    c. Activate General “SUPERVISORY” status change at the Off-Site Monitoring Station, through the Campus Network System.
    d. Annunciate “SUPERVISORY” status change at the On-site Main Campus Fire Alarm Control Panel location.
    e. Record event in the non-volatile system historical log.
    f. Record event system status change on the Main Campus Printer location.

**D. SYSTEM TROUBLE FUNCTIONS**

1. Receipt of a system trouble alarm, shall cause the following actions and indications:

    a. Activate "TROUBLE" status change at the FACP and annunciate on its LCD display, indicating device address, device type, device location, time and date
    b. Indicate "TROUBLE" status change at the respective building Remote Annunciator indicating device address, device type, device location, time and date.
    c. Activate General "TROUBLE" status change at the Off-Site Monitoring Station, through the Campus Network System.
    d. Annunciate "TROUBLE" status change at the On-site Main Campus Fire Alarm Control Panel location.
    e. Record event in the non-volatile system historical log.
    f. Record event system status change on the Main Campus Printer location.

2. The fire alarm system wiring shall be electrically supervised to automatically detect and report trouble conditions to the FACP.

3. System addressable devices shall be supervised for placement and normal operation. Removal of an addressable device or the failure of its internal electronic circuitry shall initiate a system trouble condition.

4. The FACP shall initiate a system trouble condition when the following occurs:

    a. Primary 120/220 VAC power loss.
    b. Battery disconnect.
    c. Battery low voltage.
    d. LCD annunciator panel power loss.

5. Operating an Off-Site Station agency alarm disconnect switch or any manual control commands that alter the system from its normal programmed standby configuration shall initiate a trouble condition.

6. Trouble conditions shall automatically activate an audible signal and flash the general system trouble LED indicator at the FACP. Pressing the trouble acknowledge key on the FACP shall silence the audible signal and continuously light the LED indicator, until the trouble condition is repaired. Subsequent trouble conditions shall re-sound the audible signal and again flash the LED. Each trouble condition must be individually acknowledged.

7. Removal of or failure of internal electronic circuitry of any addressable device shall initiate a system trouble condition.

**E. INSTALLATION SHOP/AS-BUILT DRAWINGS**

1. Show general layout of complete system including equipment arrangement. It shall be the responsibility of the fire alarm installing contractor to verify dimensions and ensure compatibility of all system interfaces. Shop drawings shall be maintained at the job site and shall be updated on an as needed basis. During the project life cycle, the Architect/Engineer may require updated drawings as reference during scheduled project meetings.

    a. Identify on the drawings, conduit and conductor sizes and types with number of conductors in each conduit. Provide each conduit and device with a unique identification. For addressable alarm initiation devices, the system identifier shall be the system address for that device. Signals shall be sequentially numbered with the address of the associated control module.

2. As-built drawings shall indicate point to point wiring diagrams of interconnecting wiring within all system control panels and termination enclosures showing wiring between modules and connecting field device terminals. All field numbering and/or labeling shall be reflected on As-built drawings.

3. Provide mounting details of FACP, remote transponder control panels (if any), system terminal enclosures and other boxes to building structure, showing fastener type, sizes, material and embedded depth.

## F. CONDUIT, BOXES, ENCLOSURES AND WIRING DEVICES

1. All system wiring shall be in conduit and shall comply with all applicable article of the current California-amended NEC edition.

2. Boxes shall be installed plumb and firmly in position.

3. Extension rings with blank covers shall be installed on junction boxes where required.

4. Junction boxes served by concealed conduit shall be flush mounted.

5. Upon initial installation, all wiring outlets, junction, pull and outlet boxes shall have dust covers. Dust covers shall not be removed until wiring installation when permanent dust covers or devices are installed.

6. All junction boxes shall be painted fire department red and be affixed with a decal or silk-screened label "Fire Alarm System."

7. Wet or damp locations shall require a NEMA rated enclosure suitable for the environment in which an addressable field device or module are to be installed. (i.e. monitoring of sprinkler water flow, tamper switches and OS&Y valves)

8. Electrical conduits shall enter only at the side or the bottom of control cabinets, unless designed and approved for entry on the top.

9. All conduits shall be grounded to a water main by approved ground clamps with a conductor equal in size to the largest conductor used in the system; but in no case shall the ground conductor be smaller than no. 10 AWG.

10. All openings in fire rated walls, floors or ceilings where conduits, cables or wiring trays pass through shall be fire stopped with an approved fireproofing material rated to meet or exceed the rating of the assembly penetrated.

## G. CONDUCTORS

1. Each conductor shall be identified as shown on the drawings at each with wire markers at terminal points. Attach permanent wire markers within 2 inches of the wire termination. Marker legends shall be visible.

2. All wiring shall be supplied and installed in compliance with the requirements of the National Electric Code, NFPA 70, Article 760, and that of the manufacturer-wiring guides.

3. Wiring for analog loop circuits, conventional detection circuits, speaker circuits and telephone circuits shall based on the fire alarm manufactures wiring guidelines, but shall not be smaller than #16 AWG.

4. Notification Device Circuits: Minimum wire size shall be 12 AWG for horn and strobe circuits.

5. Splices shall be made with UL listed mechanical connectors to assure reliable service.

6. Crimp-on type spade lugs shall be used for terminations of stranded conductors to binder screw or stud type terminals. Spade lugs shall have upset legs and insulation sleeves sized for the conductors.

7. Wire nuts or other solderless splicing devices shall not be used.

8. A consistent color code for fire alarm system conductors throughout the installation shall be provided. The installation contractor shall submit for approval prior to installation of wire, a proposed color code for system conductors to allow rapid identification of circuit types.

9. All nominal voltage branch circuit power feeds (120/220 VAC) shall be identified "labeled" at both ends of the circuit to indicate its source and purpose. Each FACP and control panels shall have a dedicated branch circuit with shunt trip disconnect, labeled as such.

10. Wiring within system control panels shall be arranged and routed to allow accessibility to equipment for adjustment and maintenance and to isolate nominal voltage wiring from system low voltage wiring.

## H. DEVICE DESCRIPTORS

Descriptors at SMCCCD MXL panels shall be developed following this standard SMCCCD protocol. No exceptions are allowed.

1. Address, Device, Equipment ID (if needed), Building Number, Floor Number, Description

2. Devices shall be identified by an abbreviation or code from the following table below.

| **Initiating Devices** | | | **Communication Devices** | |
|---|---|---|---|---|
| Smoke Detector | SD | | Fireman's Phone | FP |
| Heat Detector | HD | | Fireman's Jack | FJ |
| Duct Detector | DD | | | |
| Beam Detector | BD | | **Panels** | |
| Air Sampling | AS | | Fire Alarm Control Panel | FACP |
| Monitoring Device (By Name) | MSC | | Printer | PRT |
| Pull Station | PS | | Annunciator | ANN |
| Tamper Switch | TS | | Video Display Terminal | VDT |
| Water Flow | WF | | Voice Evac Panel | EVAC |
| Fire Smoke Damper | FSD | | Fan Control Panel | FAN |
| | | | Network Control Center | NCC |
| **Notification Devices** | | | Aux Power Supply | PWR |
| Audible | AUD | | Dialer | DIAL |
| Visual | VIS | | Foreign System Interface | FSI |
| Audible/Visual | AV | | | |
| Voice Evac Speaker | SPKR | | | |

3. If the device is monitoring or controlling a piece of equipment, then that equipment's ID shall immediately follow the Device. (e.g., TRI HV-5A).

4. If the description is to contain a single compass point, it should be spelled out (e.g., North). If the description uses multiple compass points such as North East it should be abbreviated (e.g., N.E.).

5. If the description contains a room number, then state the building number followed by a dash and then the three digit room number. (e.g., 2-105)

6. Examples:
   a. 02:002-007 PS B2 F1 RM 2-105
   b. 02:001-047 SD B1 F3 MECH RM
   c. 02:004-034 DD B7 F3 N.E. CORRIDOR
   d. 02:004-059 TRI HV-5A B7 F1 MCC

## PART 3 - TESTING AND ACCEPTANCE

### 3.01 FIELD QUALITY CONTROL

### A. CERTIFICATE OF COMPLIANCE

1. Complete and submit to the project engineer in accordance with NFPA 72, paragraph 1.7.2.

### B. FIELD - TESTING GENERAL

1. Each addressable analog smoke detector shall be individually field tested prior to installing the device at its designated location to ensure reliability after shipment and storage conditions. A dated log indicating correct address, type of device, sensitivity and initials of the technician performing the test - using test equipment specifically designed for that purpose - shall be prepared and kept for final acceptance documentation. After testing, the detection devices and base shall be labeled with the system address, date and initials of installing technician. Labeling shall not be visible after installation is complete.

2. Wiring runs shall be tested for continuity, short circuits and grounds before system is energized. Resistance (Megger), current and voltage readings shall be made as work progresses.

    a. A systematic record shall be maintained of all readings using schedules or charts of tests and measurements. Areas shall be provided on the logging form for readings, dates and witnesses.
    b. The acceptance inspector shall be notified before the start of any required tests. All items found at variance with the drawings or this specification during testing or inspection by the acceptance inspector shall be corrected.
    c. Test reports shall be delivered to the acceptance inspector as completed.

3. All test equipment, instruments, tools and labor required to conduct the system tests shall be made available by the installing contractor. The following equipment shall be a minimum for conducting the tests:

    a. Ladders and scaffolds as required to access all installed equipment.
    b. Multimeter for reading voltage, current and resistance.
    c. Intelligent device programmer-tester.
    d. Laptop computer with programming software for any required program revisions.
    e. Two way radios, flashlights, smoke generation devices and supplies.
    f. An approved device for measuring air flow through air duct smoke detector sampling assemblies.
    g. Decibel meter.
    h. Testing documentation.

4. In addition to the testing specified to be performed by the installing contractor, the installation shall be subject to test by the acceptance inspector.

### C. FINAL ACCEPTANCE TESTING

1. A written “Acceptance Test Procedure” (ATP) for testing the fire alarm system components and installation will be prepared by the Engineer in accordance with NFPA 72 and this specification. The contractor shall be responsible for the performance of the ATP, demonstrating the function of the system and verifying the correct operation of all system components, circuits and programming.

2. The acceptance inspector shall use the system record drawings in combination with the documents specified under sections (2.01-G and 3.01-C.) during the testing procedure to verify operation as programmed. In conducting the ATP, the acceptance inspector shall request demonstration of any or all input and output functions. The items tested shall include but not be limited to the following:

a. System wiring shall be tested to demonstrate correct system response and correct subsequent system operation in the event of:
   1. Open, shorted and grounded intelligent analog signaling line circuit.
   2. Open, shorted and grounded conventional initiating device circuits.
   3. Intelligent device removal.
   4. Primary power or battery disconnected.
   5. Incorrect device address.
b. System evacuation alarm indicating appliances shall be demonstrated as follows:
   1. All alarm notification appliances actuate as programmed.
   2. Audibility and visibility at required levels.
c. System indications shall be demonstrated as follows:
   1. Correct message display for each alarm input, at the control panel alphanumeric LCD display.
d. System on-site and/or off-site reporting functions shall be demonstrated as follows:
   1. Correct alarm custom message display, address, device type, date and time transmitted for each alarm input.
   2. Correct trouble custom message display, address, device type, date and time transmitted for each alarm input.
   3. Trouble signals received for disconnect.
e. Secondary power capabilities shall be demonstrated as follows:
   1. System primary power shall be disconnected for a period of time as specified herein. At the end of that period, an alarm condition shall be created and the system shall perform as specified for a period as specified.
   2. System primary power shall be restored for forty-eight hours and system-charging current shall be normal trickle charge for a fully charged battery bank.
   3. System battery voltages and charging currents shall be checked at the fire alarm control panel using the test codes and displayed on the LCD display.

5. In the event of system failure to perform as specified and programmed during the ATP procedure, at the discretion of the acceptance inspector, the test shall be terminated.

   a. The installing contractor shall retest the system, correcting all deficiencies and providing test documentation to the acceptance inspector.
   b. In the event that software changes are required during the ATP, the system manufacturer to compare the edited program with the original shall furnish a utility program. This utility shall yield a printed list of the changes and all system functions, inputs and outputs effected by the changes. The items listed by this program shall be the minimum acceptable to be retested before calling for resumption of the ATP. The printed list and the printer log of the retesting shall be submitted before scheduling of the ATP.
   c. The acceptance inspector may elect to require the complete ATP to be performed again if, in his opinion, modifications to the system hardware or software warrant complete retesting.

**D. DOCUMENTATION**

1. System documentation shall be furnished to the owner and shall include but not be limited to the following:

   a. System record drawings and wiring details including 3 sets of as-builts as well as as-builts on a CD-ROM in the current version of AutoCAD.
   b. System operation, installation and maintenance manuals.
   c. Written documentation for all logic modules as programmed for system operation with a matrix showing interaction of all input signals with output commands.
   d. System program “hard copy” showing system functions, controls and labeling of equipment and devices.
   e. All specified documentation as required under sections (2.01.E. and 3.01.C.).

**E. CLEANING**

1. Contractor shall thoroughly clean all areas in which it works at the end of each work day and upon completion of installation.

**F. WARRANTY/SERVICES**

2. The contractor shall warrant the entire system against system hardware and electrical defects including programming software defects for a period of one year. This period shall begin upon Substantial Completion of the project by the Architect of Record/Engineer of Record, but not prior to certification of final acceptance testing of the system. Contractor shall provide to owner a letter stating the start-date and end-date of warranty period. In addition, the contractor shall also provide an updated list of name(s) and phone number(s) for normal and off-hours contacts necessary to respond to warranty issues. Response to warranty notification shall require a reply within 24 hours of initial contact.

**G. TRAINING**

1. The fire alarm contractor shall furnish training as follows for a minimum of four employees of the system user:

   a. Training in the receipt, handling and acknowledgment of alarms.
   b. Training on system operation including manual control of output functions from the FACP.
   c. The total training requirement shall be a minimum of 4 hours, but shall be sufficient to cover all items specified.

**---- END OF SECTION -----**

# SECTION 31 20 00

# EARTH MOVING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. This Section includes the following:

1. Preparing subgrades for slabs-on-grade, walks, and pavements.
2. Excavating and backfilling for buildings and structures.
3. Drainage course for slabs-on-grade.
4. Excavating and backfilling for utility trenches.

### 1.2 DEFINITIONS

A. Backfill: Soil material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Course placed between the subbase course and hot-mix asphalt 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. Drainage Course: Course supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

F. 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 Engineer. 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 Engineer. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.

G. Fill: Soil materials used to raise existing grades.

H. 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.

I. Subbase Course: Course placed between the subgrade and base course for hot-mix asphalt pavement, or course placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

J. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.

K. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

## 1.3 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Architect and then only after arranging to provide temporary utility services according to requirements indicated.

# PART 2 - PRODUCTS

## 2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations. All materials shall be approved by the geotechnical engineer and shall conform to the recommendations of the geotechnical report.

B. Satisfactory Soils: ASTM D 2487 Soil Classification Groups GW, GP, GM, SW, SP, and SM or a combination of these groups; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487 or a combination of these groups.

1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

D. Subbase Material: 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 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

E. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 95 percent passing a 1-1/2-inch sieve and not more than 8 percent passing a No. 200 sieve.

F. 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 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

G. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.

H. 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 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.

## 2.2 ACCESSORIES

A. Warning Tape: Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility.

## PART 3 - EXECUTION

### 3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

B. Preparation of subgrade for earthwork operations including removal of vegetation, topsoil, debris, obstructions, and deleterious materials from ground surface is specified in Section 31 10 00 "Site Clearing."

C. Protect and maintain erosion and sedimentation controls, which are specified in Section 31 10 00 "Site Clearing," during earthwork operations.

### 3.2 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.

### 3.3 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 0.1 foot. 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.

### 3.4 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

### 3.5 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

B. Excavate trenches to uniform widths to provide the following 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 6 inches deeper than elevation required in rock or other unyielding bearing material, 4 inches deeper elsewhere, to allow for bedding course.

## 3.6 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 Engineer, without additional compensation.

## 3.7 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 2500 psi, may be used when approved by Geotechnical Engineer.

1. Fill unauthorized excavations under other construction or utility pipe as directed by Engineer.

## 3.8 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.

## 3.9 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. Backfill trenches excavated under footings and within 18 inches of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Division 3 Section "Cast-in-Place Concrete."

D. Provide 4-inch thick, concrete-base slab support for piping or conduit less than 30 inches below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 4 inches of concrete before backfilling or placing roadway subbase.

E. Place and compact initial backfill of satisfactory soil, free of particles larger than 1 inch 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.

F. Place and compact final backfill of satisfactory soil to final subgrade elevation.

G. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

## 3.10 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 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 satisfactory soil material.
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 2 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 2 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 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill 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 at 95 percent.
2. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 95 percent.
3. Under lawn or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 85 percent.
4. For utility trenches, compact each layer of initial and final backfill soil material at 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 1 inch.
2. Walks: Plus or minus 1 inch.
3. Pavements: Plus or minus 1/2 inch.

C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

## 3.14 SUBBASE AND BASE COURSES

A. Place subbase and base course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place subbase and base course under pavements and walks as follows:

1. Shape subbase and base course to required crown elevations and cross-slope grades.
2. Compact subbase and 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 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 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, verification and approval of design bearing capacities shall be done by the Geotechnical Engineer.

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 12 33

# PAVING AND SURFACING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes (but is not necessarily limited to):
   1. Asphalt Concrete Paving.
   2. Concrete Paving.
   3. Liquid Asphalt and Asphalt Emulsion.
   4. Aggregate Base.

B. Related work furnished under other sections but conforming to the provisions of this section:
   1. Subgrade preparation.
   2. Aggregate Base installation.

C. Related Sections:
   1. Section 01 23 00 - Alternates: Description of alternates.
   2. Section 02 41 19 - Selective Structure Demolition.
   3. Section 32 17 23 - Pavement Markings.

D. Alternates: Refer to Section 01 23 00 – Alternates, for description of work under this Section affected by alternates.

### 1.2 REFERENCES

A. ASTM International:
   1. ASTM A615: Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
   2. ASTM C150: Portland Cement.
   3. ASTM D1557: Moisture Unit Weight Relations of Soils and Aggregate Mixtures Using a 10 lb (4.5 kg) Rammer and 18 in. (457 mm) Drop.
   4. ASTM D1682: Breaking Loads and Elongation of Textile Fabrics.

B. California Code of Regulations (CCR): Title 24, Chapter 2-71, Site development Requirements for Handicapped Accessibility.

C. California Department of Transportation (C.D.T.):
   1. Standard Specifications:
      a. Section 26 Aggregate Bases.
      b. Section 37 Bituminous Seals.
      c. Section 39 Asphalt Concrete.
      d. Section 51 Concrete Structures.
      e. Section 52 Reinforcement.
      f. Section 73 Concrete Curbs and Sidewalks.
      g. Section 90 Portland Cement Concrete.
      h. Section 91 Paint.
      i. Section 92 Asphalts.
      j. Section 93 Liquid Asphalts.
      k. Section 94 Asphaltic Emulsions.
   2. Traffic Manual.
   3. Highway Design.

D. Institute of Transportation Engineers: Transportation and Traffic Engineering Handbook.

## 1.3 SUBMITTALS

A. Requirements: Refer to Section 01 32 19 – Submittal Procedures.

B. Asphalt Concrete Paving:
1. Provide two copies of material certificates signed by the material producer and the Contractor, certifying that each material item complies with or exceeds specified requirements.
2. The Contractor shall furnish a certified weight or load slip for each load of material used in the construction of the asphalt concrete pavement.

C. Concrete Paving: The Contractor shall furnish mill test reports on the cement, reinforcement bars, and aggregates, showing compliance with the respective specifications. The Testing Engineer may make concrete test cylinders and slump tests as deemed necessary to determine compliance with the Specifications.

D. Liquid Asphalt.

E. Paint.

F. Pavement Reinforcement Fabric.

G. Tack Coat.

H. Pavement Reinforcement Mesh.

I. Structural Geotextile Fabric.

## 1.4 PROJECT CONDITIONS

A. Liquid Asphalt and Asphalt Emulsion:
1. Prime coat, seal coat, and paint binder shall be applied only when the ambient temperature is above 50 degrees Fahrenheit and when temperature has not been below 35 degrees Fahrenheit for 12 hours immediately prior to application.
2. Prime coat, fog coat, seal coat, and paint binder shall not be applied when base or surfaces are wet or contain excess moisture.

B. Asphalt Concrete Paving: Asphalt concrete surfaces shall be constructed only when ambient temperature is above 50 degrees Fahrenheit and when base is dry.

## 1.5 GENERAL DESIGN CRITERIA

A. Services Areas: Approach ramps, driveways, and paved work areas in excess of 4 percent slope shall be provided with a rough texture for non-skid surface.

B. Walks and Paths: Concrete exterior slabs (walks, terraces, etc.) shall have a pitch of at least 2 percent.

C. Pavement Markings: All traffic control striping and pavement markings shall conform to the standards illustrated in the C.D.T. Standard Plans Book issued July 1992, General Road Work Section.

# PART 2 - PRODUCTS

## 2.1 PAVING MATERIALS

A. Aggregate Base: Aggregate base shall conform to Caltrans Class 2 (R value 78 min)

aggregate base, 3/4" maximum size, as specified in Section 26 of the C.D.T. Standard Specifications.

B. Asphalt Concrete Paving:
1. Paving asphalt to be mixed with aggregate shall be steam-refined asphalt, AR-4000, conforming to Section 92 of the C.D.T. Standard Specifications.
2. Mineral aggregate shall be Type B mineral aggregate as specified in Section 39 of the C.D.T. Standard Specifications.
3. Maximum aggregate size shall be as follows:

| A.C. Thickness | Max. Ag. |
|---|---|
| a. 3/4" – 1 1/2" | 1/2" |
| b. 2 & 2 1/2" | 1/2" |
| c. 3" & 4" | 3/4" |

4. Liquid asphalt for prime coat shall be Grade SC-70 in conformance with Section 93 of the C.D.T. Standard Specifications.
5. Asphaltic emulsion for paint binder, fog coat, and seal coat shall be emulsified asphalt, Type SS-1h, conforming to Section 94 of the C.D.T. Standard Specifications.

C. Portland Cement Concrete:
1. Concrete: Class A concrete conforming to Section 90 of the C.D.T. Standard Specifications.
2. Cement : Type II cement conforming to ASTM C150 as modified by Section 90 of the C.D.T. Standard Specifications.
3. Aggregate: 3/4-inch maximum size conforming to Section 90 of the C.D.T. Standard Specifications.
4. Water: Potable and free of organic matter and injurious amounts of oil, acid, alkali, or other deleterious substances.
5. Reinforcing bars: Deformed, conforming to ASTM A615.
6. Filled joints, unless noted otherwise on the Drawings: 1/4-inch thick, the full depth of the concrete section and conforming to Section 51 of the C.D.T. Standard Specifications.
7. Joint filler: Conform to Section 51 of the C.D.T. Standard Specifications for pre-molded expansion joint filler and expanded polystyrene joint filler.
8. No admixtures will be allowed without prior approval of the Engineer.

D. Pavement Marking Paint: See Section 32 17 23 – Pavement Markings.

E. Pavement Reinforcement Fabric: Pavement reinforcement fabric shall meet Caltrans Section 88-1.02, BP Petromat or approved equivalent.

F. Crack Sealant:
1. Crack sealant shall be rubberized hot-pour type and shall meet ASTM D 3405, Husky 1611 or approved equivalent.
2. Blotting Agent shall be one of: Screened sand, cement, or fly ash.

G. Tack coat: Tack coat shall meet Caltrans Section 39-4.02.

H. Pavement reinforcement mesh: Pavement reinforcement mesh for use in Type 2 Overlay shall be Glasgrid Model 8501 or approved equivalent.

I. Structural geotextile fabric: Structural geotextile fabric shall be Mirafi 500X or approved equivalent.

## PART 3 - EXECUTION

### 3.1 PREPARATION

A. Subgrade and Aggregate Base:
1. Prepare a subgrade and over excavation paragraph reference 3.4 of section 31 00 00 - EARTHWORK.
2. Aggregate base shall be compacted to 95 percent ASTM D1557. Sections 26-1.04B and 26-1.05 of the C.D.T. Standard Specifications shall apply.
3. Soil sterilant shall be applied to prepared subgrade or after installation of rock or aggregate base uniformly at the rate recommended by the manufacturer.

B. Crack Sealing:
1. Before sealing, cracks shall be cleared of dirt, dust, and all other deleterious materials to a depth of 1/4-inch to 1/2-inch.
2. Cracks 1/8-inch in width and greater shall be sealed.
3. Application of crack sealer shall be in accordance with the manufacturer's recommendations unless otherwise directed.

### 3.2 ASPHALT CONCRETE PAVING

A. General:
1. Asphalt concrete shall be proportioned, mixed, placed, spread, and compacted in conformance with Section 39 of the C.D.T. Standard Specifications.
2. Before placing asphalt concrete on untreated base, a liquid asphalt prime coat shall be applied to the base course in conformance with Section 39 of the C.D.T. Standard Specifications. Prime coat shall be applied at the rate of 0.25 gallons per square yard.
3. Before placing asphalt concrete, an asphalt emulsion tack coat shall be applied to all vertical surfaces of existing pavement, curbs, gutters, construction joints, and all existing pavement to be surfaced, in conformance with Section 39 of the C.D.T. Standard Specifications.
4. Spreading and compacting asphalt concrete shall be performed in accordance with Section 39 of the C.D.T. Standard Specifications.
5. Fog seal shall be applied to all finished surfaces of asphalt concrete pavement at a rate of 0.05 gallons per square yard, in accordance with Section 37 of the C.D.T. Standard Specifications.
6. After fog seal has been applied, ample time shall be allowed for drying before traffic is allowed on the pavement or paint striping is applied.

### 3.3 CONCRETE CONSTRUCTION

A. General:
1. All concrete shall be mixed in accordance with applicable provisions of Section 90 of the C.D.T. Standards Specifications.
2. Construction of concrete substructures shall conform to applicable provisions of Section 51 of the C.D.T. Standard Specifications. Unless noted otherwise in the Specifications, all exposed surfaces of structure shall have Class 1 surface finish.
5. No pigment shall be used in curing compounds for construction of concrete curbs, gutters, and structures.
6. All work shall be subject to field inspection. No concrete shall be placed until the District's Representative has approved the forms and reinforcement.

7. Expansion joints on curbs and gutters shall be placed 20 feet on centers, adjacent to structures, and at all returns, and shall be filled with joint filler. Control joints shall be formed 10 feet on centers. The score shall 1-inch deep minimum.
8. Concrete shall not be dropped freely where reinforcing bars will cause segregation, nor shall it be dropped freely more than 6 feet. Spouts, elephant trunks, or other approved means shall be used to prevent segregation.

## 3.4 FIELD QUALITY CONTROL

A. Asphalt Concrete Paving:
1. The specified thickness of the finished pavement shall be the minimum acceptable.
2. Conforms shall form a smooth, pond-free transition between existing and new pavement.
4. Depressions in paving between high spots are not to exceed 1/8-inch when measured below a 10 feet long straight edged placed anywhere on surface in any direction.
5. The finished asphalt pavement shall have positive drainage without ponding.

## 3.6 CLEANUP

A. General:
1. Surplus material remaining upon completion of paving operations shall become the property of the Contractor, to be removed from the work site and disposed of in a lawful manner.
2. Surfaces shall be left in a clean, neat, and workmanlike condition, and all construction waste, rubbish, and debris shall be removed from the work site and disposed of in a lawful manner.

**END OF SECTION**

# SECTION 32 17 23

# PAVEMENT MARKINGS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section includes traffic control and pavement markings and striping.

B. Related Sections:
1. Section 01 23 00 – Alternates: Work of this section affected by alternates.
2. Section 32 12 33 – Paving and Surfacing.

C. Alternates: Refer to Section 01 23 00 – Alternates, for description of work under this Section affected by alternates.

### 1.2 REFERENCES

A. Caltrans State Standard Specifications, 1992 Edition.

B. CBC – California Building Code, 2007 Edition, Section 1129B.

### 1.3 SUBMITTALS

A. Section 01 32 19 – Submittal Procedures: Submittal procedures.

B. Product Data: Submit manufacturer's printed product data on all coatings specified, including preparation and application instructions, and compliance with VOC requirements.

C. Shop Drawings: Show complete layout and location of pavement markings prior to demolition or obliteration of the existing markings.

D. Samples:
1. Submit two paper chip samples, 3 inch by 5 in size illustrating range of colors and textures available for each surface finishing product scheduled.
2. Submit two painted samples, illustrating selected colors and textures for each color and system selected. Submit on white card stock, 8 inch by 10 inch in size.
3. Pavement markers and adhesives.
4. Reflectorized markers and posts.

E. Manufacturer's Installation Instructions: Submit the manufacturer's current recommended methods of installation, including relevant limitations, safety and environmental cautions, application rates, special surface preparation procedures, and substrate conditions requiring special attention.

E. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

### 1.4 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three (3) years documented experience.

B. Applicator: Company regularly engaged and specializing in the application of pavement markings, with minimum three (3) years documented experience.

C. Regulatory Requirements: Comply with applicable codes and regulations of cognizant governmental agencies having jurisdiction, including those having jurisdiction over airborne emissions and industrial waste disposal. Where those requirements conflict with this Specification, comply with the more stringent provision.
   1. Parking spaces for the disabled shall be marked according to CBC Section 1129B.5.
   2. Symbols of Accessibility shall be marked according to CBC Section 1117B.5.8.1.1: Painted lines and markings on pavement to be 3 inches minimum in width and blue in color equal to Color 15090, per Section 32 17 23, paragraph 2.1.B.4.

D. Volatile Organic Compounds (VOC): Use only products in compliance with VOC content limits required by state and local regulations.

## 1.6 DELIVERY, STORAGE AND HANDLING

A. Section 01 60 00 – Product Requirements: Product storage and handling requirements.

B. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.

C. Container Label: Include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.

D. Paint Materials: Store at minimum ambient temperature of 45 degrees F and maximum of 90 degrees F, in ventilated area, and as required by manufacturer's instructions. Protect materials from adulteration by infiltration.

## 1.7 ENVIRONMENTAL REQUIREMENTS

A. Perform the Work of this Section under environmental conditions no less stringent than those stipulated by the manufacturers of the materials used.
   1. Take precautions necessary to avoid and mitigate the effects of wind drift in the application of liquid materials.
   2. Do not apply marking paint when weather is foggy or rainy, or ambient temperatures are below 40 degrees F, nor when such conditions are anticipated during eight hours after application.

B. Volatile Organic Content (VOC). Do not exceed State or Environmental Protection Agency maximum VOC on traffic paint.

## 1.8 EXTRA MATERIALS

A. Supply one (1) gallon of each color, type, and surface texture of paint installed. Store where directed.

B. Label each container with color, type, texture, and room locations, in addition to manufacturer's label.

## 1.9 WARRANTY

A. Section 01 77 00 – Contract Closeout: Requirements for warranties.

B. Furnish one year manufacturer's warranty for traffic paints.

# PART 2 - PRODUCTS

## 2.1 PAINTED PAVEMENT MARKINGS

A. Manufacturers:
1. Dunn-Edwards. Type: W801 Traffic Marking Paint.
2. Frazee Industries, Inc. Type: 506 Traffic Line Paint.
3. ICI Dulux. Type: 4800 Series Traffic Paint.
4. Fuller-O'Brien Corp. Type: Traffic Marking and Symbol Paint: Water-Born, Fast-Dry, Traffic Paint. D.J. Simpson (#108-273, White); (#108-280, Blue).
5. Glidden Co. Type: Glid-Guard Lifemaster Finish No. 5200/ Series, Color 1/M 79.
6. Substitutions: Section 01 60 00 – Product Requirements: Product Options and Substitutions.

B. Line and Zone Marking Paint: Dunn Edwards Vin-L-Stripe Traffic Marking Paint, W801 Series, epoxy modified acrylic latex based, specifically formulated for application to asphalt and concrete vehicular traffic surfaces. Provide paint certifiable by the manufacturer as being in accordance with the California Air Resources Board (CARB) rules in effect at the time of application.
1. Factory mixed, quick drying and non-bleeding.
2. Paint to be slip resistant and provide a minimum of 0.6 static coefficient of friction.
3. Colors:
   a. Text: White.
   b. Parking divider stripes: White.
   c. No parking zone markings: Yellow.
   d. No parking curb: Red.
   e. Fire Lane curb: Red.
   f. Accessible Zone markings: White and Blue as shown on drawings.
   g. Crosswalk striping: White.
   h. Directional arrows: White.
   i. Driving lane dividers: White.
4. Blue paint for the Symbol of Accessibility: Match color No. 15090 in Federal Standard 595A as specified in Section 2-1720 of CCR Title 24 Handicap Regulations (similar to Royal Blue).
   a. Blue Color. Glidden Co. "Glid-Guard Lifemaster Finish No. 5200 /series, Color 1/M 79", or approved equivalent.

C. Thermoplastic Stripes and Markings:
1. Thermoplastic stripes and markings shall be hot applied conforming to CSS Section 84 and shall be Cataphote-Catatherm brand, Pavemark thermoplastic brand, or approved equal.
2. Thermoplastic stripes and markings shall have a minimum skid friction value of BPN 35.

D. Pavement Markers and Adhesives:
1. Pavement markers shall be two-way retroflective "Blue" markers and shall conform to the applicable requirements of CSS Section 85.
2. Adhesive for pavement markers shall be standard set epoxy adhesive conforming to the requirements of CSS Section 95-2.05.

## 2.2 EQUIPMENT

A. Pressurized, self-contained paint machine capable of applying a straight line from 2 inches to 6 inches wide, with consistent coverage of a minimum of 150 square feet per gallon.

B. Machine Calibration:
1. Paint Line Measuring Device: Calibrate automatic line length gauges to maintain tolerance of plus or minus 25 feet per mile.

2. Paint Guns: Calibrate to simultaneously apply paint binder at uniform rates as specified with an allowable tolerance of plus or minus 1 mil.

C. Other Equipment:
1. For application of crosswalks, intersections, stop lines, legends and other miscellaneous items by walk behind stripers, hand spray or stencil trucks, apply with equipment meeting requirements of this section. Do not use hand brushes or rollers.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify surfaces are ready to receive Work as instructed by product manufacturer.

C. Examine surfaces scheduled to be finished prior to commencement of work. Report conditions capable of affecting proper application.

### 3.2 PREPARATION

A. General: Clean and prepare surfaces to receive traffic paint in accordance with CSS Section 84-3.05 and these special provisions. Where required, remove existing striping and markings by wet blasting or equivalent method. Do not use dry sandblasting or other dust producing methods.

B. Maintenance and Protection of Traffic:
1. Provide short term traffic control in accordance with Section 01 51 00.
2. Prevent interference with marking operations and to prevent traffic on newly applied markings before markings dry.
3. Maintain travel lanes between 7:00 AM to 9:00 AM, and between 4:00 PM and 6: 00 PM.
4. Maintain access to existing buildings and other properties requiring access.

C. Locate markings as shown on Drawings. Provide qualified technicians to supervise equipment and application of markings. Lay out markings using guidelines, templates and forms. Obtain verification from Architect for confirmation of lay out, colors, and placement of markings.

D. Correct defects and clean surfaces affecting work of this section. Sand all gloss finishes to sheen. Remove existing coatings that are flaking or otherwise in unacceptable condition to receive paint. Preparation or removal of coatings containing lead must be performed in accordance with all EPA and OSHA guidelines.

E. Concrete and Masonry Surfaces: Pressure wash to remove all dirt, loose mortar, scale, salts, alkalies, and other detrimental substances. Remove oils and grease with solution of trisodium phosphate; rinse well and allow to dry. Remove all plant growth, including all growth spores and spore residue where designated.

F. Asphalt Concrete: All surfaces must be cleaned free from grease, oil, dirt, mildew, stains and other contaminants that would cause adhesion problems. Remove loose, peeling or chalky paint by high-pressure washing or other appropriate methods. Surfaces must be completely dry before application.
1. Allow asphalt concrete to age for 30 days before starting pavement marking.

## 3.3 APPLICATION

A. Agitate paint for 1-15 minutes prior to application to ensure even distribution of paint pigment.

B. Traffic Paint: Apply marking paint at rate of one gallon per 150 square feet (equivalent to approximately one gallon for 450 lineal feet of 4 inch wide stripe). Rate can increase to a maximum of 400 square feet per gallon based on conditions of surface to be coated.

C. Apply paint with mechanical equipment in accordance with CSS Section 84-3.04:
1. Provide uniform straight edges without overspray.
2. Uniform line width of 4 inches, unless otherwise noted on Drawings.
4. Provide hatching in accessible parking areas as required by Code.
5. Use single line striping between parking stalls.
6. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 13 mils.
6. Identify parking spaces with text where shown on drawings:

D. Striping Layout:
1. Traffic stripe: Single and double, solid and broken, and of the color to match existing conditions.
2. Place traffic striping in patterns to match existing conditions, contractor shall document.

E. Thermoplastic Stripes and Markings:
1. Thermoplastic stripes and markings shall be applied hot in conformance with manufacturer's recommended instructions and the applicable requirements of CSS Section 84-2.06.

F. Pavement Markers:
1. Install pavement markers to delineate the location of fire hydrants along the loop road. No markers shall be installed until surface has been approved by Engineer and until at least 10 days after slurry seal on asphalt concrete has been placed. Place markers in accordance with CSS Section 85-1.06.

G. Accessibility Symbol: Apply international accessibility symbol on pavement surface in accordance with CCR Title 24 Section 1129B. The surface of each accessible parking space or stall shall have a surface identification duplicating the following scheme:
1. By outlining a profile view of a wheelchair with occupant in white on blue background. Locate profile view so that it is visible to a traffic enforcement office when vehicle is properly parked in the space. Size: 36 inches high by 36 inches wide.

H. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.

I. Prior to applying, mix paint a sufficient length of time to thoroughly mix the pigment and vehicle together, and keep thoroughly agitated during its application.

J. Apply each coat to uniform appearance. Apply each coat of paint slightly darker than preceding coat unless specified otherwise.

K. Apply markings to indicated dimensions at indicated locations.

L. Prevent splattering and over spray when applying markings.

M. Unless material is track free at end of paint application convoy, use traffic cones to protect markings from traffic until track free. When vehicle crosses a marking and tracks it or when splattering or over spray occurs, eradicate affected marking and resultant tracking and apply new markings.

N. Collect and legally dispose of residues from painting operations.

## 3.4 APPLICATION TOLERANCES

A. Maximum Variation from Wet Film Thickness: 1 mil.

B. Maximum Variation from Wet Paint Line Width: Plus or minus 1/8 inch.

C. Maximum Variation from Specified Application Temperature: Plus or minus 5 degrees F.

## 3.5 CLEANING

A. Comply with requirements of Section 01 74 00 – Cleaning.

B. Upon completion of work, remove surplus materials and rubbish and clean off spilled or splattered paint resulting from this work.

## 3.6 PROTECTION OF FINISHED WORK

A. Protect painted pavement markings from vehicular and pedestrian traffic until paint is dry and track free. Follow manufacturer's recommendations or use minimum of 30 minutes. Consider barrier cones as satisfactory protection for materials requiring more than 2 minutes dry time.

## 3.7 FIELD QUALITY CONTROL

A. Inspect for incorrect location, insufficient thickness, line width, coverage, retention, uncured or discolored material, and insufficient bonding.

B. Repair lines and markings, which after application and curing do not meet following criteria:
   1. Incorrect Location: Remove and replace incorrectly placed patterns.
   2. Insufficient Thickness, Line Width, Paint Coverage: Prepare defective material by acceptably grinding or blast cleaning to roughen marking surface. Remove loose particles and debris. Apply new markings on cleaned surface in accordance with this Section.
   3. Uncured or Discolored Material, Insufficient Bonding: Remove defective markings in accordance with this Section and clean pavement surface one foot beyond affected area. Apply new markings on cleaned surface in accordance with this Section.

C. Replace defective pavement markings as specified throughout 1 year warranted period. Replace markings damaged by anti-skid materials, studded tires, tire chains, chemical deicers, snow plowing or other loss of marking material regardless of cause. When markings are damaged by pavement failure or by Owner's painting, crack sealing, or pavement repair operations, Contractor is released from warranty requirements for damaged work.

## 3.8 SCHEDULE OF COLORS

A. Stripes between standard parking stalls: White.

B. Stripes between accessible parking stalls: White.

C. No parking zones diagonal striping: White.

D. Diagonal Striping at KEEP CLEAR zone: Yellow.

E. Directional Arrows: White.

F. NO PARKING stenciled letters: White.

G. KEEP CLEAR stenciled letters: White.

H. Fire Lane curb: Red.

I. FIRE LANE NO PARKING stenciled letters: White.

J. Loading Zone curb: Yellow.

K. LOADING ONLY stenciled letters: White.

**END OF SECTION**