Rocky Vista University
Billings, Montana

CONSTRUCTION DOCUMENTS
FOR BUILDING PERMIT

PROJECT MANUAL
VOLUME 3 OF 4
(Divisions 20 through 29)

August 20, 2021

ARCHITECTURE
URBAN DESIGN
INTERIOR DESIGN

3003 Larimer St, Denver, CO 80205
P: 303-861-5704 www.ozarch.com

PROJECT

ROCKY VISTA UNIVERSITY
Montana Location
4130 Monad Road
Billings, Montana 59106

OWNER

ROCKY VISTA UNIVERSITY
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Parker, Colorado 80134
(303) 373-2008
Contact: Chuck Flood

OWNER'S REPRESENTATIVE

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Audubon, Pennsylvania 19403
(215) 817-0216
Contact: Scott Dorn

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CIVIL

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Carbondale, Colorado 81623
(970) 963-6520
Contact: Marc Diemer

STRUCTURAL

JVA, INC.
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Boulder, Colorado 80302
(303) 444-1951; (303) 444-1957 FAX
Contact: Laura Coates

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Arvada, Colorado 80002
(303) 422-7400; (303) 422-7900 FAX
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Matt Arzt, Plumbing/HVAC
Justin Patterson, Electrical

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Billings, Montana 59101
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Westminster, Colorado 80031
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00 01 07 SEALS PAGE

PROJECT

ROCKY VISTA UNIVERSITY
Montana Location
4130 Monad Road
Billings, Montana 59106

ARCHITECT OF RECORD

OZ ARCHITECTURE, INC.
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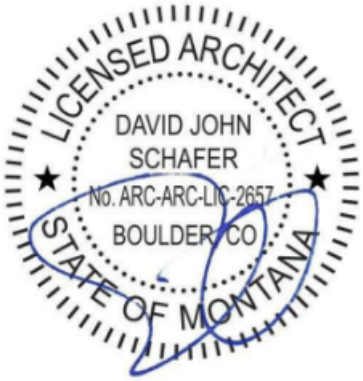
Denver, Colorado 80205

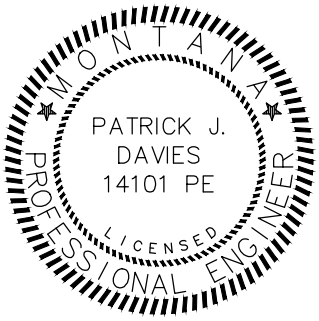


08/20/2021

David Schafer, AIA, LEED AP
Principal
MT License number: ARC-ARC-LIC-2657

00 01 07 SEALS PAGE

PROJECT	**ROCKY VISTA UNIVERSITY** Montana Location 4130 Monad Road Billings, Montana 59106
CIVIL ENGINEER OF RECORD	**SANDERSON STEWART** 1300 North Transtech Way Billings, Montana 59102



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PROJECT	**ROCKY VISTA UNIVERSITY** Montana Location 4130 Monad Road Billings, Montana 59106
LANDSCAPE ARCHITECT OF RECORD	**DHM DESIGN** 311 Main Street Carbondale, Colorado 81623

00 01 07 SEALS PAGE

PROJECT **ROCKY VISTA UNIVERSITY**
Montana Location
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Billings, Montana 59106

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1319 Spruce St
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08-19-2021

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PROJECT

ROCKY VISTA UNIVERSITY
Montana Location
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PLUMBING/HVAC ENGINEER OF RECORD

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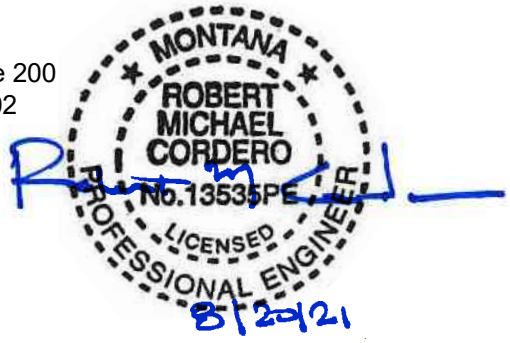
00 01 07 SEALS PAGE

PROJECT

ROCKY VISTA UNIVERSITY
Montana Location
4130 Monad Road
Billings, Montana 59106

ELECTRICAL ENGINEER OF RECORD

BCER ENGINEERING
5420 Ward Road, Suite 200
Arvada, Colorado 80002



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LEGEND AND NOTES

Sections listed in **bold** have been issued for construction under Bid Package No. 1 and Bid Package No. 2. Balance of sections are for information only.

Section 01 26 00 - Contract Modification Procedures and Section 01 29 00 - Payment Procedures issued under Package No. 1 contain changes with the issuance of Bid Package No. 2.

Section 01 10 00 - Summary, Section 01 45 00 - Quality Control, Section 01 92 13 - Facility Operation Procedures, Section 02 32 00 - Geotechnical Investigation, Section 07 11 13 - Bituminous Dampproofing (section deleted), Section 07 23 00 - Perimeter Insulation, Section 07 92 00 - Joint Sealants, Section 31 20 00 - Earth Moving and Section 32 13 13 - Concrete Paving issued under Package No. 2 contain changes with the issuance of the 75% Construction Documents.

Section 01 10 00 - Summary, Section 01 45 00 - Quality Control, Section 03 31 00 - Structural Concrete, Section 05 34 00 - Acoustical Metal Decking, Section 07 11 13 - Bituminous Dampproofing (section added), Section 07 92 00 - Joint Sealants, Section 14 22 00 - Machine-Room-Less Elevators (section deleted), Section 14 24 00 - Hydraulic Elevators (section added) and Section 31 20 00 - Earth Moving issued under Package No. 2 contain changes with the issuance of the Construction Documents for Building Permit.

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Refer to the Civil Drawings and the Montana Public Works Standard Specifications for the balance of the information.

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APPENDIX

SECTION 21 05 00
FIRE PROTECTION

PART 1 - GENERAL

1.0 RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.1 DESCRIPTION OF WORK

This Section and the Drawings outline the general, but not specific, scope of the project's Fire Protection System. The successful Contractor will be the Engineer of Record for the design of the system. The Design and Engineering of the Fire Protection System shall be by the Fire Protection Contractor. It is the Contractor's responsibility that the system meets all the requirements of NFPA (FM if applicable) and the Authority Having Jurisdiction.

This Section specifies Automatic Sprinkler Systems for buildings and structures. Materials and equipment specified in this Section include:

Pipe, Fittings, Valves and Specialties
Sprinklers and Accessories

Products furnished but not installed by the Contractor include sprinkler head cabinet with spare sprinkler heads. Furnish to the Owner's maintenance personnel for installation in an approved location.

Related Sections: The following Sections contain requirements that relate to this Section:

Division 2 Section "Fire Service Piping" for fire protection piping from fire service mains to a point 5-feet outside the building.
Division 7 Section "Joint Sealers" for materials and methods for sealing pipe penetrations through basement walls and fire/smoke barriers.
Division 23 Section "Mechanical Identification" for labeling and identification of fire protection piping system and components.
Division 21 Section "Fire Pumps" for pumps, motors, controllers and accessories.
Division 23 sections inclusive.

1.2 DEFINITIONS

Pipe sizes used in this Specification are Nominal Pipe Size (NPS).

Other definitions for Fire Protection Systems are listed in applicable NFPA Codes or Standards.

Working Plans as used in this Section means those documents (including drawings and calculations) prepared pursuant to the requirements contained in NFPA 13 for obtaining approval of the Authority Having Jurisdiction.

1.3 SYSTEM DESCRIPTION

Provide a complete Fire Sprinkler System for the entire building (including, but not limited to, electrical rooms, mechanical rooms and the remainder of the building), except designated areas as shown on the drawings, which will not require fire sprinkler coverage, will be specifically noted with "No A/S".

Fire Protection System is a "Wet-Pipe" system employing automatic sprinklers attached to a piping system containing water and connected to a water supply so that water discharges immediately from sprinklers opened by fire.

Elevator Shafts and Machine Rooms: Sprinklers shall be installed in elevator machinery rooms, at the top of elevator shafts, and at the bottom of elevator shafts.

Sprinkler coverage shall be designed for Ordinary Hazard Group One. Sprinkler heads shall be high temperature classification (286 degree F).
The sprinkler heads in the elevator machinery room shall be supplied from a separate, independent sprinkler branch line with a readily accessible indicating shutoff valve located outside of the shaft or machinery room.
At least one (1) smoke detector shall be located in the same area of each sprinkler head. Activation of any one (1) of these detectors shall cause emergency recall (if equipped) of the elevator(s) and also put the building into alarm.
In addition to smoke detectors, at least one (1) thermal detector, with 190 degree F fixed temperature, shall be installed in the same area of each sprinkler head. The circuitry for the thermal detector(s) shall be separate from the circuitry for the smoke detector(s). When any thermal detector is activated, a shunt-trip circuit breaker shall automatically disconnect all electrical power to the elevator machinery room and the elevator machinery.
Division 26 shall provide Fire Detection System (detectors, wiring, panel, etc.) for complete operation of the Fire Sprinkler System for the elevator shaft and machine room.

1.4 SUBMITTALS

The contractor is to prepare a submittal schedule that coincides with the overall construction schedule. This submittal schedule should include a list of individual products to be submitted under each specification section. This submittal schedule shall also include dates for anticipated review, shipment, and on-site delivery times of the submitted product.

Submittals shall be prepared by authorized equipment dealers, vendors, suppliers, or representative of the products submitted. Include contact and business information of the equipment dealers, vendors, suppliers and representatives. Products and equipment submitted shall also be representative of the products and equipment to be procured and installed. General product data and shop drawings downloaded from unaffiliated websites will not be reviewed or accepted.

After review, submittals shall be returned together with review comments and specific actions (if required) to be taken by the Contractor. Typical comments and actions will be:

Reviewed – resubmittal not required.
Rejected – resubmittal required.
Revise and Resubmit – resubmittal required.
Make Corrections as Noted – resubmittal not required unless corrections cannot be met.

The Engineer shall be given a submittal review time of ten (10) working days upon receipt of submittal. Previous submittal rejection or revision shall not compress this review time. It shall be the contractor’s responsibility to ensure these review and/or re-review times are incorporated into the submittal schedule with enough lead time as not to affect overall construction schedule.

Product data for each type sprinkler head, valve, piping and piping specialty, fire protection specialty, fire department connection and any equipment installed in accordance with the Contract Documents.

Shop drawings and hydraulic calculations prepared in accordance with NFPA13. Do not proceed with the installation of the work until the Architect/Engineer review of shop drawings is received.

Contractor shall stamp shop drawings indicating compliance with applicable codes and contract drawings. Contractor shall stamp drawing "Approved for Construction".

Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule. Submittals shall be prepared and submitted in accordance with the submittal schedule. The contractor is to determine and coordinate submittal review times, lead times and delivery times of submitted products as it coincides with the overall construction schedule. Submittals submitted in bulk or under a single division will not be review and will be sent back as “revise and resubmit”.

If more than one (1) re-submittals (either for shop drawings or for as-built drawings) are made by the Contractor, the Owner reserves the right to charge the Contractor for subsequent reviews by their consultants. Such extra fees shall be deducted from payments by the Owner to the Contractor.

Maintenance data for each type sprinkler head, valve, piping specialty, fire protection specialty, fire department connection and hose valve specified, for inclusion in operating and maintenance manual specified in Division 1.

Welder's Qualification Certificate.

Test Reports and Certificates, including "Contractor's Material and Test Certificate for Aboveground Piping" and "Contractor's Materials and Test Certificate for Underground Piping" as described in NFPA13.

Hydraulic calculations and drawings created by the Contractor and submitted to the Engineer shall have the signed stamp of a professional engineer registered in the State of Colorado and familiar with this type of installation and with previous similar experience or the signature with certification number of a Level 4 Senior Engineering Technician of the National Institute for Certification of Engineering Technology (practicing in the Fire Protection field) certifying that the Fire Sprinkler System has been hydraulically calculated in compliance with NFPA and governing codes.

Fire sprinkler piping design drawings shall show, and be coordinated with, all ductwork, air devices, lighting, electrical panels and structural elements of the Building.

Electronic submittals shall be packaged as a bookmarked multi-page single PDF.

1.5 REQUESTS FOR INFORMATION

All “Requests for Information” submitted by the Contractor shall include a proposed solution and an estimated cost/schedule impact. Any RFI’s that do not contain this required information will be sent back to the Contractor unanswered.

Schedule the work to provide the Engineer a minimum review time of five (5) business days upon receipt of RFIs to provide a response.

1.6 HYDRAULIC DESIGN

The Fire Sprinkler System shall be hydraulically calculated by the Contractor in compliance with NFPA 13.

The water supply curve shall be developed by deducting 10% to a maximum of 10 PSI from the static and residual pressures measured during the flow test. The final fire protection system demand shall be below the water supply curve.

Velocities in pipes shall be shown on hydraulic calculations. Velocities in overhead piping shall not exceed 32-feet per second. Velocities in underground piping shall not exceed 16-feet per second.

Allow 10-feet of loss for electric water flow switches or as recommended by the manufacturer and note on hydraulic calculations.

The Fire Protection Contractor shall provide as many sets of hydraulic calculations as necessary, performed and submitted to prove that the most remote and demanding areas are calculated.

Design information shall be permanently affixed to the main riser as described in NFPA 13.

Before hydraulically calculating fire sprinkler system, the Fire Protection Contractor shall verify exact water flow data with Local Water and/or Fire Department. A copy of the water flow test data from the Local Water and/or Fire Department shall accompany the hydraulic calculations.

1.7 QUALITY ASSURANCE

Installer Qualifications: Installation and alterations of fire protection piping, equipment, specialties, and accessories, and repair and servicing of equipment shall be performed only by qualified installer. The term "qualified" means experienced in such work (experienced shall mean having a minimum of five (5) previous projects similar in size and scope to this project), familiar with all precautions required, and has complied with all the requirements of the Authority Having Jurisdiction. The Contractor shall be licensed for the design and installation for the specific type of system in the jurisdiction where the work is to be performed and the State of Colorado. Upon request, submit evidence of such qualifications to the Engineer. Refer to Division 1 Section "Definitions and Standards" for definitions for "Installers".

Qualifications for Welding Processes and Operators: Comply with the requirements of AWS D10.9, "Specifications of Qualifications of Welding Procedures and Welders for Piping and Tubing, Level AR-3".

1.8 SEQUENCING AND SCHEDULING

Schedule rough-in installations with installations of other building components.

Minimum time frame for notice of inspections, tests and meetings is five (5) days and list the persons to be notified.

1.9 EXTRA STOCK

Heads: For each style and temperature range (and length for dry heads) required, furnish additional sprinkler heads per NFPA 13.

Obtain receipt from Owner that extra stock has been received.

Wrenches: Furnish two (2) spanner wrenches for each type and size of valve connection and fire hose coupling.

PART 2 - PRODUCTS

2.0 MATERIALS AND PRODUCTS

General: Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, temperature ratings, and capacities as indicated. Where not indicated, provide proper selection as determined by Installer to comply with installation requirements. Provide sizes and types matching piping and equipment connections; provide fittings of materials which match pipe materials used in fire protection systems.

All equipment used on this project shall be new and UL Listed, unless noted or specified otherwise.

2.1 MANUFACTURERS

Manufacturer: Subject to compliance with requirements, provide fire protection system products from one of the following:

Gate Valves:

Nibco
Kennedy Valve, Division of ITT Grinnell Valve Co., Inc.
Mueller
Stockham
Grinnell
Milwaukee
Or equal

Swing Check Valves:

Mueller
Kennedy Valve, Division of ITT Grinnell Valve Co., Inc.
Viking
Victaulic
Globe
Tyco Fire Products
Reliable Automatic Sprinkler Company
Or equal

Butterfly and Ball Valves:

Grinnell
Mueller
Victaulic
Milwaukee
Or equal

Grooved Mechanical Couplings:

Gruvlok
Victaulic Company of America
Or equal

Double Check Valve Assembly:

UL Listed and FM approved for Fire Protection Service
Approved by the Water District

Fire Protection Specialty Valves:

Reliable Automatic Sprinkler Co., Inc.
Viking Corporation
Globe
Tyco Fire Products
Victaulic Company of America
Or equal

Fire Department Connection:

Croker
Potter-Roemer
Elkhart
Or equal

Sprinkler Heads:

Reliable Automatic Sprinkler Co., Inc.
Viking Corp.
Globe
Tyco Fire Products
Victaulic Company of America
Or equal

Fire Protection Specialties:

Croker-Standard Division; Fire-End & Croker Corp.
Elkhart Brass Mfg. Co., Inc.
Potter Roemer, Inc.
Or equal

Inspector's Test and Drain Module:

Victaulic
A.G.F.
Or equal

Flexible Stainless Steel Hose Branch Line:

UL Listed and FM approved for Fire Protection Use, Braided Hose only.

2.2 BASIC IDENTIFICATION

General: Provide identification complying with Division 23 Basic Mechanical Materials and Methods section "Mechanical Identification", in accordance with the following listing:

Fire Protection Piping: Pipe markers.
Fire Protection Valves: Valve tags.
Fire Protection Signs: Provide the following signs:

At each sprinkler valve, sign indicating what portion of system valve controls.
At each outside alarm device, sign indicating what authority to call if device is activated.
At door to each sprinkler control valves, sign reading **"FIRE CONTROL"**.
At each drain or test, sign indicating its purpose.

Attach to the riser a metal sign indicating the name, address and telephone number of the Fire Protection Contractor. Also indicate the date of installation.

2.3 BASIC PIPING SPECIALTIES

General: Provide piping specialties complying with Division 23 Basic Mechanical Materials and Methods section "Piping Specialties", in accordance with the following listing:

Pipe Escutcheons
Dielectric Unions
Drip Pans
Pipe Sleeves
Sleeve Seals
Fire Barrier Penetration Seals

2.4 BASIC SUPPORTS AND ANCHORS

General: Provide supports and anchors for fire protection system in compliance with NFPA 13.

Adjustable steel clevis hangers, adjustable steel band hangers, or adjustable band hangers, for horizontal-piping hangers and supports.
Two-bolt riser clamps for vertical piping supports.
Steel turnbuckles and malleable iron sockets for hanger-rod attachments.
Concrete inserts, top-beam C-clamps, side beam or channel clamps or center beam clamps for building attachments.
Concrete inserts and other type hangers penetrating into or through structural members shall be submitted (by the Fire Protection Contractor) to, and have the approval of, the Structural Engineer contracted for this project.
Powder driven studs shall not be allowed.
Hangers (which are acceptable for Project) and hanger spacing shall be in accordance with NFPA-13.

2.5 PIPE AND FITTINGS (UNDERGROUND)

Underground pipe shall be ductile iron, thickness Class 52 unless specified otherwise by local authorities or ANSI/AWWA C150/A21.50-81; 350 PSI pressure rating; tar coated outside, cement mortar lined inside in accordance with ANSI/AWWA C104/A21.4-80. Full lengths of pipe shall be utilized to the greatest extent possible.

Fittings for ductile iron pipe shall be 250 PSI pressure rating in accordance with ANSI/AWWA C110-77, tar coated outside, and cement lined inside in accordance with ANSI/AWWA C104/A21.4-80.

Joints shall be push-on or mechanical type as per ANSI/AWWA C111/A21.11-80.

Other pipe and fitting types in compliance with NFPA 24 are acceptable.

2.6 PIPE AND TUBING MATERIALS (INSIDE BUILDING)

General: Refer to Part 3 Article "Pipe Applications" for identification of systems where the below specified pipe and fitting materials are used.

Steel Pipe: ASTM A 53, A795 or A135, Schedule 40 or Schedule 10, U.S. manufacture, Black steel pipe, plain ends.

U.S. manufactured pipe is required.

Schedule 5 pipe shall not be allowed.

The Corrosion Resistance Ratio of the pipe shall be 1.00 or greater. Documentation shall be presented with product submittal.

Schedule 10 pipe shall only be allowed for pipe sizes 2-1/2 inch and larger.

Provide galvanized, Schedule 40, piping system for pre-action system.

2.7 FITTINGS (INSIDE BUILDING)

Cast Iron Threaded Fittings: ANSI B16.4, Class 125 standard pattern, for threaded joints. Threads shall conform to ANSI B1.20.1.

Malleable Iron Threaded Fittings: ANSI B16.3, Class 300, standard pattern, for threaded joints. Threads shall conform to ANSI B1.20.1. Install steel pipe with threaded joints and fittings for 2-inch and smaller and where shown on drawings.

Steel Fittings: ASTM A234, seamless or welded, for welded joints.

Grooved Mechanical Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 47 Grade 32510 malleable iron; or ASTM A53, Type F or Types E or S.

Grooved Mechanical Couplings: Consist of ductile or malleable iron housing, a synthetic rubber gasket of a central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure roll-grooved pipe and fittings. Grooved mechanical couplings including gaskets used on dry-pipe systems shall be listed for dry-pipe service.

Grooved Mechanical Fittings and Couplings for the entire fire protection system shall be of the same manufacturer as submitted in shop drawing equipment review.

Cast Iron Threaded Flanges: ANSI B16.1, Class 250; raised ground face, bolt spot faced.

Cast Bronze Flanges: ANSI B16.24, Class 300; raised ground face, bolt holes spot faced.

Plain end, hooker type, or push-on fittings or couplings shall not be allowed.

Bushings and reducing couplings shall not be allowed.

UL listed and Factory Mutual approved segmentally welded fittings are acceptable.

Mechanical Tee’s shall not be allowed.

2.8 JOINING MATERIALS

Welding Materials: Comply with Section II, Part C, ASME Boiler and Pressure Vessel Code for welding materials appropriate for the wall thickness and chemical analysis of the pipe being welded.

Gasket Materials: Thickness, materials and type suitable for fluid or gas to be handled, and design temperatures and pressures.

2.9 GENERAL DUTY VALVES

Gate Valves - 2-Inch and Smaller: Body and bonnet of cast bronze, 175 pound cold water working pressure – non-shock, threaded ends, solid wedge, outside screw and yoke, rising stem, screw-in bonnet, and malleable iron handwheel. Valves shall be capable of being repacked under pressure, with valve wide open.

Gate Valves - 2-1/2 Inch and Larger: Iron body; bronze mounted, 175 pound cold water working pressure – non-shock. Valves shall have solid taper wedge; outside screw and yoke, rising stem; flanged bonnet, with body and bonnet conforming to ASTM A 126 Class B; replaceable bronze wedge facing rings; flanged ends; and a packing assembly consisting of a cast iron gland flange, brass gland, packing, bonnet, and bronze bonnet bushing. Valves shall be capable of being repacked under pressure, with valve wide open.

Butterfly Valves: 2-1/2 Inch to 8-inch shall be listed to 175 PSI with optional internal tamper switch. Body shall be ductile iron with a corrosion resistant coating. Seat shall be field replaceable without the use of special tools. The valve shall be provided with stem bushings to isolate the stem from the stem journal. The valve body shall be machined with a retaining lip for positive retention of the seat to provide drip tight shutoff at full rated differential pressure with the downstream piping removed.

Ball Valves: 1-1/2 Inch and smaller shall be threaded, forged brass construction, with teflon seats and blow out proof stem.

Ball Valves: 2-Inch to 3-inch shall be listed to 300 PSI with optional internal tamper switch. Body shall be ductile iron with corrosion resistant coating. Ball shall be 316 stainless steel.

Swing Check Valves: MSS SP-71; Class 175, cast iron body and bolted cap conforming to ASTM A 126, Class B; horizontal swing, with a bronze disc or cast-iron disc with bronze disc ring, and flanged ends. Valve shall be capable of being refitted while the valve remains in the line.

Double Check Valve Assembly: Double check valve assembly shall be UL listed for fire protection service and USC-CCCF approved. Installation arrangement shall be per manufacturer's recommendations.

2.10 BASIC METERS AND GAUGES

Provide meters and gauges as specified below.

UL Listed and FM Approved for fire protection service.
For water gauges 0-300 PSI range.
For air gauges, 0-80 PSI range graduated in 1 PSI increments with a 80 PSI -250 PSI retard range

2.11 ALARM DEVICE AND FIRE PROTECTION SPECIALTIES

General: Types and sizes shall mate and match piping and equipment connections. Provide fire protection specialties, UL listed, in accordance with the following listing. Provide sizes and types which mate and match piping and equipment connections.

Water Flow Indicators: Vane type waterflow detector, rated to 250 PSIG; designed for horizontal or vertical installation; have two (2) SPDT circuit switches to provide isolated alarm and auxiliary contacts, 7 ampere 125 volts AC and 0.25 ampere 24 volts DC; complete with factory-set field-adjustable retard element to prevent false signals, tamper-proof cover which sends a signal when cover is removed, and with activation time retarding capability set at 30 seconds. The setting shall be verified through the Inspectors Test prior to Final Inspection.

Supervisory Switches: Provide products recommended by manufacturer for use in service indicated. SPST, normally closed contacts, designed to signal valve in other than full open position.

2.12 AUTOMATIC SPRINKLERS

Sprinkler Heads: Provide sprinkler heads with a temperature rating per NFPA 13. Sprinkler head K factor should be selected to optimize the hydraulics of the fire sprinkler system. A minimum K factor of 5.6 is to be used.

Sprinkler Head Finishes: All sprinkler head finishes shall be coordinated with the Owner and Architect prior to purchase and installation of sprinkler heads:

Upright, Pendent and Sidewall Styles: Chrome plated, factory brass, in finish spaces, exposed to view; rough bronze finish for heads in unfinished spaces and not exposed to view. Heads shall be stainless steel where installed exposed to acids, chemicals, or other corrosive fumes.
Concealed Style: Rough brass, adjustable, with painted White cover plate. GEM Models FR946 and F946 Clean Line Sprinklers are not acceptable.
Recessed Style: Bright chrome, with bright chrome escutcheon plate. GEM Models FR948 and F948 recessed sprinklers are not acceptable.
See drawings for additional sprinkler type requirements.

Sprinkler Head Cabinet and Wrench: Finished steel cabinet, suitable for wall mounting, with hinged cover and space for spare sprinkler heads plus sprinkler head wrench. Provide amounts of each style per NFPA 13. Locate head cabinet on shop drawing submittal.

Plastic fire sprinkler escutcheons are not acceptable.

2.13 FIRE DEPARTMENT CONNECTIONS

Wall Type Siamese Connections: Polished chrome cast brass, 2-way flush wall type, with wall escutcheon and having National Standard threads, for the connections size indicated, as specified in NFPA 1963. Each inlet shall have a clapper valve, and cap and chain. Unit shall have wall escutcheon of cast-brass, finish to match connections, with words "STANDPIPE - FIRE DEPT. CONNECTION" or "AUTO SPKR. - FIRE DEPT. CONNECTION" or "AUTO SPKR. AND STANDPIPE - FIRE DEPARTMENT CONNECTION" in raised letters. Contractor shall verify threads with Local Fire Department.

Fire Department connections including location shall meet the approval of the Fire Department Having Jurisdiction.

2.14 INSPECTOR'S TEST AND DRAIN ASSEMBLY

Provide an alarm test module of a manufacturer listed in Paragraph 2.2.

Comply with NFPA 14, for draining and testing of wet standpipe system.

Test and drain piping shall be routed to exterior. Location shall meet Owner's approval.

PART 3 - EXECUTION

3.0 EXAMINATION

Do not proceed until unsatisfactory conditions have been corrected.

3.1 PIPE APPLICATIONS

Install Schedule 40 steel pipe with threaded joints and fittings for 2-inch and smaller.

Install Schedule 40 steel pipe with roll-grooved ends and grooved mechanical coupling or with threaded joints and fittings.

Acceptable alternates to Schedule 40 pipe shall be installed per manufacturer's recommendations.

3.2 PIPING INSTALLATIONS

Provide a minimum 5'-0" cover for all underground pipe installations. Install in accordance with AWWA C600.

Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of piping systems. So far as practical, install piping as indicated. Drawings are diagrammatic in character and do not necessarily indicate every required offset, valve, fitting, etc.

Deviations from approved "Working Plans" for sprinkler piping require written approval of the Authority Having Jurisdiction. Written approval shall be on file with the Engineer prior to deviating from the approved "Working Plans".

Install sprinkler piping to provide for system drainage in accordance with NFPA 13.

Use approved fittings to make all changes in direction, branch takeoffs from mains, and reductions in pipe sizes. Welded outlet branch pipe fittings are acceptable.

Install unions in pipe 2-inch and smaller, adjacent to each valve. Unions are not required on flanged devices or in piping installations using grooved mechanical couplings.

Install flanges or flange adapters on valves, apparatus, and equipment having 2-1/2 inch and larger connections.

For welded pipe, all cutouts (coupons) shall be removed prior to installation.

Hangers and Supports: Comply with the requirements of NFPA 13. Hanger and support spacing and locations for piping joined with grooved mechanical couplings shall be in accordance with the grooved mechanical coupling manufacturer's written instructions for rigid systems. Provide protection from damage where subject to earthquake in accordance with NFPA 13.

Make connections between underground and aboveground piping using an approved transition piece strapped or fastened to prevent separation.

Install mechanical sleeve seal at pipe penetrations in basement and foundation walls. Refer to Division 23 Section "Basic Piping Materials and Methods".

All piping penetrating walls to structure shall be sleeved and sealed per Division 23.

Install test connections sized and located in accordance with NFPA 13 complete with shutoff valve. Test connections may also serve as drain pipes.

Install pressure gauge on the riser or feed main at or near each test connection. Provide gauge with a connection not less than 1/4-inch and having a soft metal seated globe valve, arranged for draining pipe between gauge and valve. Install gauges to permit removal, and where they will not be subject to freezing.

The fire line entry valves shall have monitoring electrical switches, the wiring from which shall be carried to the Fire Annunciating Panel.

The Fire Protection Contractor shall be responsible for the coordination of his installation with all other contractors.

Protect adjacent area where pipe cutting and threading takes place (e.g. floors, ceilings, walls, etc.).

There shall be no fire sprinkler piping in Electrical Rooms, other than piping serving sprinklers directly in that room, or installed over any electrical panels.

Provide spring-loaded check valve at top of drain risers.

Install pressure gauges on city and system sides of fire entry valve assembly.

Install hangers straight and true and piping parallel to building lines.

3.3 PIPE JOINT CONSTRUCTION

Welded Joints: AWS D10.9, Level AR-3.

Threaded Joints: Conform to ANSI B1.20.1, tapered pipe threads for field cut threads. Join pipe, fittings, and valves as follows:

Note the internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.
Align threads at point of assembly.
Apply appropriate tape or thread compound to the external pipe threads.
Assemble joint to appropriate thread depth. When using a wrench on valves, place the wrench on the valve end into which the pipe is being threaded.
Damaged Threads: Do not use pipe with threads which are corroded or damaged. If a weld opens during cutting or threading operations, that portion of pipe shall not be used.

Flanged Joints: Align flange surfaces parallel. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly to appropriate torque specified by the bolt manufacturer.

Mechanical Grooved Joints: Roll grooves on pipe ends dimensionally compatible with the couplings.

End Treatment: After cutting pipe lengths, remove burrs and fins from pipe ends.

3.4 VALVE INSTALLATIONS

General: Install fire protection specialty valves, fittings and specialties in accordance with the manufacturer's written instructions, NFPA-13 and the Authority Having Jurisdiction.

Gate Valves: Install electronically supervised-open indicating valves so located to control all sources of water supply except fire department connections. Where there is more than one (1) control valve, provide permanently marked identification signs indicating the portion of the system controlled by each valve.

Valve at water main tap shall be underground gate valve with roadway box.

Install a UL Listed and FM Approved for fire protection service backflow prevention assembly to meet the Jurisdiction's Water Department requirements.

3.5 SPRINKLER HEAD INSTALLATIONS

Any sprinklers with any paint on them, as a result of the painting of the sprinkler piping, shall be replaced. The sprinkler system shall then be hydrostatically tested again at the Contractor's expense.

Sprinkler heads shall be positioned so as to comply with NFPA 13 for any obstructions.

Run piping concealed above heated furred ceilings and in joists to minimize obstructions. Expose only heads.

Protect sprinkler heads against mechanical injury with standard guards.

Provide heads in "pocketed" areas caused by exposed duct, piping or beams.

Sprinkler heads shall be located in the center of all 2-foot x 2-foot ceiling tiles, quarter points, and along the centerline lengthwise of 2-foot x 4-foot ceiling tiles.

Use proper tools to prevent damage during installations.

Install sprinkler piping in a manner such that mechanical equipment, ceiling tiles or lights can be accessed and easily removed.

Minimum fire sprinkler head temperature rating for sprinklers in electrical rooms shall be 212 degree F. Keep sprinklers as far from transformers and/or panels as spacing allows.

3.6 FIRE DEPARTMENT CONNECTION INSTALLATIONS

Install automatic drip valves at the check valve on the fire department connection to the mains. Route drain to exterior.

Install mechanical sleeve seal at pipe penetration in outside walls.

3.7 INSTALLATION OF BASIC IDENTIFICATION

General: Install mechanical identification in accordance with Division 23 Basic Mechanical Materials and Methods section "Mechanical Identification".

Install fire protection signs on piping in accordance with NFPA 13 and NFPA 14 requirements.

3.8 INSTALLATION OF METERS AND GAUGES

Install meters and gauges in accordance with Division 23 Basic Mechanical Materials and Methods section "Meters and Gauges".

3.9 FLEXIBLE STAINLESS STEEL HOSE BRANCH LINE

Install per requirements associated with the listing of U.L. and Factory Mutual for installation in suspended or sheet rock ceilings. Provide factory brackets to maintain listing of installation for applicable sprinkler head type connection.

3.10 FIELD QUALITY CONTROL

Flush, test and inspect Sprinkler Piping Systems in accordance with NFPA 13, Standard for Installation of Sprinkler systems, Edition 2010 - Chapter 8.

The Fire Sprinkler System shall not be connected to underground piping until the fire service main is tested and approved.

The Fire Protection Contractor shall conduct and bear the costs of all necessary tests of the Fire Protection Work, furnish all labor, power and equipment. All piping shall be tested with water as required, the tests witnessed by the Authority Having Jurisdiction.

The Fire Protection Piping shall be tested under a hydrostatic pressure of not less than 200 PSIG, for a duration of not less than two (2) hours.

Replace piping system components which do not pass the test procedures specified, and retest repaired portion of the system at Fire Protection Contractor's expense.

All piping tests (pneumatic and hydrostatic) shall be conducted prior to the application of any painting materials. This will prevent hidden leaks and/or repainting of repaired/altered piping.

3.11 SYSTEM CERTIFICATION

The Contractor shall provide the Owner with written certification prior to final inspection, that all new equipment:

Has been visually inspected and functionally tested as required by the specifications.
Is installed entirely in accordance with the manufacturer's recommendations within the limitations of the system's UL listings and NFPA criteria.
Is in proper working order.

3.12 FINAL INSPECTION AND TESTING

The Contractor shall make arrangements with the Owner for final inspection and witnessing of the final acceptance tests. The Fire Protection Contractor, the Alarm System Contractor and the Owner will conduct the final inspection and witness the final acceptance test.

All tests and inspections required by the referenced Codes and Standards, and the Owner shall be performed by the Contractor.

The inspecting committee as referenced above will visit the job site to inspect the work and witness the final acceptance tests when they have been advised by the Contractor that the work is completed and ready for test. If the Work is not complete or the test is unsatisfactory, the Contractor shall be responsible for the Consultant's extra time and expenses for re-inspection and witnessing the re-testing of the work. Such extra fees shall be deducted from payments by the Owner to the Contractor.

After the system has been inspected and tested, a certificate, "Contractor's Material and Test Certificate Sprinkler System - Water Spray System", shall be provided by the Contractor and shall be signed by him or his representative, the Owner's representative and by a representative of the Fire Department if appropriate. Sufficient copies shall be prepared to ensure the

Engineer, Owner, all Inspecting Authorities and the Contractor have a copy for their files. The Contractor shall prepare one (1) test report for each inspection performed whether successful or not.

The signing of the Certificate by the Owner's representative shall in no way prejudice any claim against the Contractor for faulty material, poor workmanship, or failure to comply with Inspecting Authority's requirements or Local Ordinances.

Contractor shall provide at least five (5) working days notice for all tests.

All sprinkler supervisory initiating devices shall be functionally tested to verify proper operation.

All supervisory functions of each initiating device shall be functionally tested.

Receipt of all alarm and trouble signals, initiated during the course of the testing, shall be verified at the Fire Alarm Control Panel.

3.13 OPERATION AND MAINTENANCE MANUAL

The Contractor shall provide the Owner with a loose-leaf manual containing:

A detailed description of the systems.
A detailed description of routine maintenance required or recommended or which would be provided under a maintenance contract including a maintenance schedule and detailed maintenance instructions for each type of device installed.
Manufacturer's Data Sheets and Installation Manuals/Instructions for all equipment installed.
A list of recommended spare parts.
Service Directory.
Full size reproducibles of the Record Drawings (stamped and signed per Section 1.6).
Hydraulic Calculations (stamped and signed per Section 1.6).

Within fifteen (15) days of the completion of the work, three (3) copies of the manual shall be submitted for approval.

3.14 RECORD DRAWINGS

The Contractor shall provide and maintain on the site an up-to-date record set of approved shop drawing prints which shall be marked to show each and every change made to the sprinkler system from the original approved Shop Drawings. This shall not be construed as authorization to deviate from or make changes to the shop drawings approved by the Owner without written instruction from the Owner in each case. This set of drawings shall be used only as a record set.

Upon completion of the Work, the record set of prints shall be used to prepare complete, accurate final record drawings reflecting any and all changes and deviations made to the sprinkler system.

The Owner, at his option and at the Contractor's expense, may require revised hydraulic calculations depending on the extent and nature of field changes.

The Record Drawings and Hydraulic Calculations shall have the signed stamp of a Professional Engineer registered in the State of Colorado or the signature with certification number of a Level 4 Senior Engineering Technician of the National Institute for Certification of Engineering Technology certifying the Record Drawings and the Hydraulic Calculations accurately represent the completed Fire Protection System.

3.15 GUARANTEE PERIOD

Guarantee: The Contractor shall guarantee all materials and workmanship for a period of one (1) year beginning with the date of final acceptance by the Owner. The Contractor shall be responsible during the design, installation, testing and guarantee periods for any damage caused by him (or his subcontractors) or by defects in his (or his subcontractor's) work, materials, or equipment.

Emergency Service: During the installation and warranty period, the Contractor shall provide emergency repair service for the sprinkler system within four (4) hours of a request by the Owner for such service. This service shall be provided on a twenty-four (24) hour per day, seven (7) days per week basis.

3.16 TRAINING

The Contractor shall conduct two (2) training sessions of four (4) hours each to familiarize the building personnel with the features, operation and maintenance of the sprinkler systems. Training sessions shall be scheduled by the Owner at a time mutually agreeable to the Contractor and the Owner.

3.17 WATER DAMAGE

The Fire Protection Contractor shall be responsible for any damage to the work of others, to building and property/materials of others caused by leaks in automatic sprinkler equipment, unplugged or disconnected pipes or fittings, and shall pay for necessary replacement or repair of work or items so damaged during the installation and testing periods of the automatic sprinkler work.

3.18 WORK BY OTHERS

Electrical Contractor shall wire all water flow switches and tamper switches on valves to central alarm panel, and shall also wire alarm bells or light/horn.

END OF SECTION 21 05 00

SECTION 22 00 00

BASIC PLUMBING REQUIREMENTS

PART 1 - GENERAL

1.0 RELATED DOCUMENTS

Drawings and general provisions of Contract, including the, General and Supplementary Conditions, Division-1 Conditions specification sections apply to the Division 22 specifications and drawings.

Related Sections: Refer to all sections in Division 22 and Division 22 drawings. Refer to Division 26 specification section and Division 26 drawings.

1.1 SUMMARY

This Section specifies the basic requirements for plumbing installations and includes requirements common to more than one (1) section of Division 22. It expands and supplements the requirements specified in sections of Division 1 and Division 22.

The Contractor shall coordinate and co-operate with Owner at all times for all new to existing connections, system shutdowns and restart-up, flushing and filling both new and existing systems.

Provide temporary piping services where required to maintain existing areas operable, as shown on the drawings.

Coordinate all services shutdown with the Owner, provide temporary services as shown on the drawings.

The Contractor shall be responsible for the maintenance operation and servicing of all new plumbing systems which are to be used by the Owner during the time of any occupancy and use of any areas within the construction limitations before final completion or acceptance of the systems. A written record of maintenance, operation and servicing shall be turned over to the Owner prior to final acceptance.

1.2 INSTALLER'S QUALIFICATIONS

All Plumbing Work shall be performed by a State of Colorado Licensed Contractor under the supervision of a Licensed Plumber. The General Contractor shall verify that plumbers are currently licensed by the State of Colorado and shall supply the General Contractor Project Manager with names and license numbers. Plumbing Contractors shall have a minimum of three (3) years of satisfactory performance in conducting the type of work specified.

1.3 ACCESSIBILITY

Install equipment and materials to provide required access for servicing and maintenance. Coordinate the final location of concealed equipment and devices requiring access with final location of required access panels and doors. Allow ample space for removal of all parts that require replacement or servicing.

Furnish hinged steel access doors with concealed latch, whether shown on drawings or not, in all walls and ceilings for access to all concealed valves, shock absorbers, air vents, motors, balancing cocks, and other operating devices requiring adjustment or servicing. Refer to Division 1 for access door specification.

The minimum size of any access door shall not be less than the size of the equipment to be removed or 24-inch x 24-inch if used for service only, unless size is indicated on Drawings.

Furnish doors to trades performing work in which they are to be built, in ample time for building-in as the work progresses. Whenever possible, group valves, cocks, etc., to permit use of minimum number of access doors within a given room or space.

Factory manufactured doors shall be of a type compatible with the finish in which they are to be installed.

Access doors in fire-rated walls and ceilings shall have equivalent UL label and fire rating.

1.4 ROUGH-IN

Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

Refer to equipment shop drawings and manufacturer's requirements for actual provided equipment for rough-in requirements.

1.5 REQUIREMENTS OF REGULATORY AGENCIES

Refer to Division 1.

Execute and inspect all work in accordance with all Underwriters, local and state codes, rules and regulations applicable to the trade affected as a minimum, but if the plans and/or specifications call for requirements that exceed these rules and regulations, the greater requirement shall be followed. Follow recommendations of NFPA, EPA, OSHA and ASHRAE.

Comply with standards in effect at the date of these Contract Documents, except where a standard or specific date or edition is indicated.

The handling, removal and disposal of regulated refrigerants shall be in accordance with U.S. EPA, state and local regulations.

After entering into contract, Contractor will be held to complete all work necessary to meet these requirements without additional expense to the Owner.

1.6 REQUIREMENTS OF LOCAL UTILITY COMPANIES

Comply with rules and regulations of local utility companies. Include in bid the cost of all valves, valve boxes, meter boxes, meters and such accessory equipment which will be required for the project.

1.7 PERMITS AND FEES

Refer to Division 1.

Owner shall pay all tap, development, meter, etc., fees required for connection to municipal and public utility facilities.

Contractor shall arrange for and pay for all permits, inspections, licenses and certificates required in connection with the Work.

1.8 PLUMBING INSTALLATIONS

Drawings are diagrammatic in character and do not necessarily indicate every required offset, valve, fitting, etc.

Drawings and specifications are complementary. Whatever is called for in either is binding as though called for in both.

Drawings shall not be scaled for rough-in measurements or used as shop drawings. Where drawings are required for these purposes or have to be made from field measurement, take the necessary measurements and prepare the drawings.

Before any Work is installed, determine that equipment will properly fit the space; that required piping grades can be maintained and that ductwork can be run as contemplated without interferences between systems, with structural elements or with the work of other trades.

Coordinate the installation of mechanical materials and equipment above and below ceilings with suspension system, light fixtures, and other building components.

Coordinate ceiling cavity space carefully with all trades. In the event of conflict, install mechanical and electric systems within the cavity space allocation in the following order of priority.

Plumbing waste, vent piping and roof drain mains and leaders
Supply, return and exhaust ductwork
Fire sprinkler mains and leaders
Electrical conduit
Domestic hot and cold water, medical gas piping
Pneumatic control piping
Fire sprinkler branch piping and sprinkler runouts

Verify all dimensions by field measurements.

Arrange for chases, slots, and openings in other building components to allow for plumbing installations.

Coordinate the installation of required supporting devices and sleeves to be set in poured in place concrete and other structural components, as they are constructed.

Sequence, coordinate, and integrate installations of plumbing materials and equipment for efficient flow of the work. Give particular attention to large equipment requiring positioning prior to closing-in the building.

Coordinate the cutting and patching of building components to accommodate the installation of plumbing equipment and materials.

Where mounting heights are not detailed or dimensioned, install plumbing piping and overhead equipment to provide the maximum headroom possible.

Install plumbing equipment to facilitate maintenance and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.

Coordinate connection of plumbing systems with exterior underground and overhead utilities, services and Division 33. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.

1.9 EXCAVATING AND BACKFILLING

General:

Provide all necessary excavation and backfill for installation of Plumbing Work in accordance with Division 1.
In general, follow all regulations of OSHA as specified in Part 1926, Subpart P, "Excavations, Trenching and Shoring". Follow specifications of Division 22 as they refer specifically to the Plumbing Work.

Contact Owners of all underground utilities to have them located and marked, at least two (2) business days before excavation is to begin. Also, prior to starting excavation, brief employees on marking and color codes and train employees on excavation and safety procedures for natural gas lines. When excavation approaches gas lines, expose lines by carefully probing and hand digging.

Provide all necessary pumping, cribbing and shoring.

Walls of all trenches shall be a minimum of 6-inch clearance from the side of the nearest mechanical work. Install pipes with a minimum of 6-inch clearance between them when located in same trench.

Pipe Trenching:

Dig trenches to depth, width, configuration, and grade appropriate to the piping being installed. Dig trenches to 6-inches below the level of the bottom of the pipe to be installed. Install 6-inch bed of pea gravel or squeegee, mechanically tamp to provide a firm bed for piping, true to line and grade without irregularity. Provide depressions only at hubs, couplings, flanges, or other normal pipe protrusions.

Backfilling shall not be started until all work has been inspected, tested and accepted. All backfill material shall be reviewed by the Soils Engineer. In no case shall lumber, metal or other debris be buried in with backfill.

Trench Backfill:

Backfill to 12-inches above top of piping with pea gravel or squeegee, the same as used for piping bed, compact properly.
Continue backfill to finish grade, using friable material free of rock and other debris. Install in 6-inch layers, each properly moistened and mechanically compacted prior to installation of ensuing layer. Compaction by hydraulic jetting is not permissible.

After backfilling and compacting, any settling shall be refilled, tamped, and refinished at this Contractor's expense.

This Contractor shall repair and pay for any damage to finished surfaces.

Complete the backfilling near manholes using pea gravel or squeegee, installing it in 6-inch lifts and mechanically tamping to achieve 95 percent compaction.

Use suitable excavated material to complete the backfill, installed in 6-inch lifts and mechanically compacted to seal against water infiltration. Compact to 95 percent for the upper 30-inches below paving and slabs and 90 percent elsewhere.

1.10 CUTTING AND PATCHING

This Article specifies the cutting and patching of mechanical equipment, components, and materials to include removal and legal disposal of selected materials, components, and equipment.

Refer to Division 1.

Do not endanger or damage installed work through procedures and processes of cutting and patching.

Arrange for repairs required to restore other work, because of damage caused as a result of plumbing installations.

No additional compensation will be authorized for cutting and patching work that is necessitated by ill-timed, defective, or non-conforming installations.

Perform cutting, fitting, and patching of mechanical equipment and materials required to:

Uncover work to provide for installation of ill-timed work;
Remove and replace defective work;
Remove and replace work not conforming to requirements of the Contract Documents;
Remove samples of installed work as specified for testing;
Install equipment and materials in existing structures;
Upon written instructions from the Architect, uncover and restore work to provide for Architect observation of concealed work.

Cut, remove and legally dispose of selected plumbing equipment, components, and materials as indicated, including, but not limited to removal of plumbing piping, plumbing fixtures and trim, and other plumbing items made obsolete by the new work.

Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.

Provide and maintain an approved type of temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.

Locate, identify, and protect mechanical, plumbing and electrical services passing through remodeling or demolition area and serving other areas required to be maintained operational.

1.11 TEMPORARY FACILITIES

New Plumbing Fixtures shall not be used without written permission from the owner.

1.12 PRODUCT OPTIONS AND SUBSTITUTIONS

Refer to the Instructions to Bidders and Division 1, "PRODUCTS, OPTIONS AND SUBSTITUTION".

1.13 PLUMBING SUBMITTALS

Refer to the Conditions of the Contract (General and Supplementary), Division 1 and AIA Document A201, "SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES".

The contractor is to prepare a submittal schedule that coincides with the overall construction schedule. This submittal schedule should include a list of individual products to be submitted under each specification section. This submittal schedule shall also include dates for anticipated review, shipment and on-site delivery times of the submitted product.

The Engineer shall be given a submittal review time of **ten (10)** working days upon receipt of submittal. Previous submittal rejection or revision shall not compress this review time. It shall be the contractor's responsibility to ensure these review and/or re-review times are incorporated into the submittal schedule with enough lead time as not to affect overall construction schedule.

The manufacturer's material or equipment listed in the schedule or identified by name on the drawings are the types to be provided for the establishment of size, capacity, grade and quality. If alternates are used in lieu of the scheduled names, the cost of any changes in construction required by their use shall be borne by Contractor.

Submittals shall be prepared by authorized equipment dealers, vendors, suppliers, or representative of the products submitted. Include contact and business information of the equipment dealers, vendors, suppliers and representatives. Products and equipment submitted shall also be representative of the products and equipment to be procured and installed. General product data and shop drawings downloaded from unaffiliated websites will not be reviewed or accepted.

All equipment shall conform to the State and/or Local Energy Conservation Standards.

Submittal of shop drawings, product data, and samples will be accepted only when submitted by and stamped by the Contractor. Data submitted from subcontractors and material suppliers directly to the Architect will not be processed unless prior written approval is obtained by the Contractor.

Submit all submittal items required for each Specification Section**.** Submittals shall be prepared and submitted in accordance with the submittal schedule. The contractor is to determine and coordinate submittal review times, lead times and delivery times of submitted products as it coincides with the overall construction schedule. Submittals submitted in bulk or under a single division will not be review and will be sent back as "revise and resubmit".

If more than one (1) re-submittals (either for shop drawings or for as-built drawings) are made by the Contractor, the Owner reserves the right to charge the Contractor for subsequent reviews by their consultants. Such extra fees shall be deducted from payments by the Owner to the Contractor.

Before starting Work, prepare and submit to the Architect all shop drawings and descriptive equipment data required for the project. Unless each item is identified with specification section and sufficient data to identify its compliance with the specifications and drawings, the item will be returned without action or "Revise and Resubmit". Continue to submit shop drawings after each Engineer's action, until a "Reviewed" action is received. The Contractor shall submit the total number of sets as called for in Division 1 to the Architect for final distribution. Submittals shall include the following specified materials and, in addition, any materials not listed below but which are specified in the individual sections of Division 22 which follow.

Pipe Markers
Sanitary and storm drainage piping, fittings and joining materials
Water treatment equipment, including water softeners
Plumbing fixtures, trim, fittings and rough-in dimensions, cleanouts and drains
Domestic water piping, fittings and joining materials
Domestic water heaters and domestic hot water generators
Water hammer arresters

Medical/Laboratory gas equipment, piping, fittings and joining materials
Process piping
Valves, including pressure relief and pressure regulating
Pumps
Tanks, including expansion tanks
Thermometers and pressure gauges
Boilers, burners, trim and feed equipment
Piping specialties, including hot water and steam
Supports, anchors and seals
Expansion compensators
Flexible pipe connectors
Water flow meters
Vibration isolators
Insulation, including plastic pipe fitting insulation covers and manufacturer's installation instructions
Heat exchangers
Automatic control systems

Wiring diagrams, control panelboards, motor test data, motors, starters and controls for electrically operated equipment furnished by plumbing trades.

Identify each item with equipment tag with specification section and sufficient data to certify its compliance with the specifications.

Electronic submittals shall be packaged as a bookmarked multi-page single PDF file and shall not be over 5MB. Electronic Submittals over 5MB will not be accepted and will be returned un-reviewed.

1.14 REQUESTS FOR INFORMATION

All “Requests for Information” submitted by the Contractor shall include a proposed solution and an estimated cost/schedule impact. Any RFI’s that do not contain this required information will be sent back to the Contractor unanswered.

Schedule the work to provide the Engineer shall be given a minimum review time of **five (5)** upon receipt of RFIs to provide a response.

1.15 PLUMBING COORDINATION DRAWINGS

Prepare and submit a complete set of **3-D** Coordination Drawings as necessary or required by the Engineer showing major elements, components, and systems of plumbing equipment and materials in relationship with other trades, sub-trades and building components. Prepare drawings to an accurate scale of 1/4"=1'-0" or larger. Indicate the locations of all equipment and materials, including clearances for installing and maintaining insulation, servicing and maintaining equipment, valve stem movement, and similar requirements. Indicate movement and positioning of large equipment into the building during construction.

This project has been completed in Revit. This Contractor shall review the model created by the Architect/Engineer that illustrated the design intent of the project. This model is not intended to be used as a shop drawing, but as a tool to enable the Contractor to fabricate and coordinate the installation of the work described in these documents.

Prepare and submit a complete set of 3-D Coordination/Fabrication Drawings showing major elements, components, and systems of mechanical equipment and materials in relationship with other trades, sub-trades and building components. Prepare 3D drawings to an accurate scale of 1/4"=1'-0" or larger when plotted. Indicate the locations of all equipment and materials, including clearances for installing and maintaining insulation, servicing and maintaining equipment, valve stem movement, and similar requirements. Indicate movement and positioning of large equipment into the building during construction.

Review in detail all floor plans, reflected ceiling plans, elevations, sections, and details to conclusively coordinate with all trades and integrate all installations. Indicate locations where space is limited, and where sequencing and coordination of installations are of importance to the efficient flow of the work, including (but not necessarily limited to) the following:

Mechanical equipment room layouts;
Specific equipment installations, including:

Chillers;
Cooling Towers;
Boilers;
Pumps and Compressors;
Tanks and Heat Exchangers;
Furnaces;
Air Handling Units;
Domestic Water Heaters;
Backflow Preventers;
Pressure Reducing Stations;
Domestic Water Booster Pumps;
Water Meters;
Grease and Sand/Oil Interceptors;
Sewage Ejector Systems;
Sump Pump Systems;

Work in pipe spaces, chases, trenches, and tunnels;
Exterior wall penetrations;
Ceiling plenums which contain piping, ductwork, or equipment in congested arrangement;
Installations in mechanical riser shafts, at typical sections and crucial offsets and junctures;
Pipe expansion loops;
Numbered valve location diagrams;
Exterior underground lines in common excavation;
Manifold piping for multiple equipment units;
Water Heater flue and roof penetrations.
Elevations and locations of Division 33 connections.

1.16 PRODUCT LISTING

Prepare listing of major plumbing equipment and materials for the project, within two (2) weeks of signing the Contract Documents and transmit to the Mechanical Engineer.

Unless otherwise specified, all materials and equipment shall be of domestic (USA) manufacture and shall be of the best quality used for the purpose in commercial practice.

Provide all information requested.

Submit this listing as a part of the submittal requirement specified in Division 1, "PRODUCTS AND SUBSTITUTION".

When two (2) or more items of same material or equipment are required (plumbing fixtures, pumps, valves, etc.) they shall be of the same manufacturer. Product manufacturer uniformity does not apply to raw materials, bulk materials, pipe, tube, fittings (except flanged and grooved types), sheet metal, wire, steel bar stock, welding rods, solder, fasteners, motors for dissimilar equipment units, and similar items used in work, except as otherwise indicated.

Provide products which are compatible within systems and other connected items.

1.17 NAMEPLATE DATA

Provide permanent operational data nameplate on each item of plumbing equipment, indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar essential data. Locate nameplates in an accessible location.

1.18 DELIVERY, STORAGE, AND HANDLING

Refer to Division 1.

Deliver products to project properly identified with names, model numbers, types, grades, compliance labels, and similar information needed for distinct identifications; adequately packaged and protected to prevent damage during shipment, storage, and handling.

Store equipment and materials at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage, dirt, dust and moisture.

Coordinate deliveries of plumbing materials and equipment to minimize construction site congestion. Limit each shipment of materials and equipment to the items and quantities needed for the smooth and efficient flow of installations.

Provide factory-applied plastic end-caps on each length of pipe and tube, except for hub-and-spigot and no-hub pipe. Maintain end-caps through shipping, storage and handling to prevent pipe-end damage and prevent entrance of dirt, debris, and moisture.

Protect stored pipes and tubes. Elevate above grade and enclose with durable, waterproof wrapping. When stored inside, do not exceed structural capacity of the floor.

Protect flanges, fittings, and specialties from moisture and dirt by inside storage and enclosure, or by packaging with durable, waterproof wrapping.

1.19 RECORD DOCUMENTS

Refer to Division 1. The following paragraphs supplement the requirements of Division 1.

Keep a complete set of record document prints or electrical mark-ups in custody during entire period of construction at the construction site.

Mark drawing prints to indicate revisions to piping, size and location both exterior and interior; including locations of control devices and units requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; actual inverts and locations of underground piping; concealed equipment, dimensioned to column lines; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e., strainers, expansion compensators, tanks, etc.); RFI's; change orders; concealed control system devices. Changes to be noted on the drawings shall include final location of any piping relocated more than 1'-0" from where shown on the drawings.

Mark Equipment Schedules on the drawings with changes to Manufacturer, Model Number, and data based on reviewed shop drawings.

At the completion of the project, mark all valve tag numbers on the drawings and turn these drawings over to the General Contractor for his submission to the Architect. This Contract will not be considered completed until these record drawings have been received and reviewed by the Architect.

1.20 OPERATION AND MAINTENANCE DATA

Refer to Division 1.

In addition to the information required by Division 1 for maintenance data, include the following information:

Description of plumbing equipment, function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of all replaceable parts.
Manufacturer's printed operating procedures to include start-up, break-in, routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
Servicing instructions and lubrication charts and schedules.
Manufacturer's service manuals for all plumbing equipment provided under this Contract. Include the valve tag list.
Name, Address and Telephone Number of party to be contacted for twenty-four (24) hour service for each item of equipment.
Starting, stopping, lubrication, equipment identification numbers and adjustment clearly indicated for each piece of equipment.
Complete parts list.
Plumbing warranties.

This Contract will not be considered completed, nor will final payment be made, until all specified material is received in this Operating and Maintenance Report and the manual is reviewed by the Architect.

1.21 LUBRICATION OF EQUIPMENT

Refer to Division 1. The following paragraphs supplement the requirements of Division 1.

Contractor shall properly lubricate all plumbing pieces of equipment which he provided before turning the building over to the Owner. He shall attach a linen tag or heavy duty shipping tag on the piece of equipment showing the date of lubrication and the type and brand of lubricant used.

Furnish the Engineer with a Electronic Document, of each item lubricated and type of lubricant used, no later than two (2) weeks before completion of the project, or at time of acceptance by the Owner of a portion of the building and the mechanical systems involved.

1.22 WARRANTIES

Refer to Division 1 for procedures and submittal requirements for warranties. Refer to individual equipment specifications for warranty requirements. In any case, the entire mechanical system shall be warranted no less than one (1) year from the time of acceptance by the Owner.

Compile and assemble the warranties specified in Division 22, into a separated set of vinyl covered, three-ring binders, tabulated and indexed for easy reference.

Provide complete warranty information for each item to include product or equipment to include date or beginning of warranty or bond; duration of warranty or bond; and names, addresses, and telephone numbers and procedures for filing a claim and obtaining warranty services.

1.23 CLEANING

Refer to Division 1.

Refer to other sections of Division 22, for requirements cleaning strainers and disinfection of plumbing systems prior to final acceptance.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION – NOT USED

END OF SECTION 22 00 00

SECTION 22 05 00

COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.0 DESCRIPTION OF WORK

Extent of Piping Specialties Work required by this section is indicated on drawings and schedules and by requirements of this section.

Types of Piping Specialties specified in this section include the following:

Escutcheons
Dielectric Fittings
Mechanical Sleeve Seal
Fire and Smoke Barrier Penetration Seal
Drip Pan
Pipe Sleeve
Sleeve Seals

Piping Specialties furnished as part of factory-fabricated equipment, are specified as part of equipment assembly in other Division 22 sections.

1.1 QUALITY ASSURANCE

Manufacturer's Qualifications: Firms regularly engaged in manufacture of piping specialties of types and sizes required, whose products have been in satisfactory use in similar service for not less than five (5) years.

Codes and Standards:

ASME B 31.9 "Building Services Piping" for materials, products, and installation.
Safety valves and pressure vessels shall bear the appropriate ASME label.
Fabricate and stamp air separators and compression tanks to comply with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.
ASME "Boiler and Pressure Vessel Code," Section IX, "Welding and Brazing Qualification" for qualifications for welding processes and operators.

1.2 SUBMITTALS

Product Data: Submit manufacturer's technical product data, including installation instructions, and dimensioned drawings for each type of manufactured piping specialty. Include pressure drop curve or chart for each type and size of pipeline strainer. Submit schedule showing manufacturer's figure number, size, location, and features for each required piping specialty.

Shop Drawings: Submit for fabricated specialties, indicating details of fabrication, materials, and method of support.

Maintenance Data: Submit maintenance data and spare parts lists for each type of manufactured piping specialty. Include this data, product data, and shop drawings in maintenance manual; in accordance with requirements of Division 1.

PART 2 - PRODUCTS

2.0 MANUFACTURERS

Manufacturer: Subject to compliance with requirements, provide products by one of the following:

Pipe Escutcheons:

Chicago Specialty Mfg. Co.
Producers Specialty & Mfg. Corp.
Sanitary-Dash Mfg. Co.

Dielectric Fittings:

B & K Industries, Inc.
Capital Mfg. Co.; Division of Harsco Corp.
Eclipse, Inc.
Epco Sales, Inc.
Perfection Corp.
Rockford-Eclipse Division

Mechanical Sleeve Seal:

Thunderline Corp.
"Metraseal" by Metraflex Co.

Fire and Smoke Barrier Penetration Seal:

Electrical Products Division/3M
Dow Corning
Flame Stop, Inc.
MetaCaulk
Hilti
HoldRite

2.1 PIPE ESCUTCHEONS

General: Provide pipe escutcheons as specified herein with inside diameter closely fitting pipe outside diameter, or outside of pipe insulation where pipe is insulated. Select outside diameter of escutcheon to completely cover pipe penetration hole in floors, walls, or ceilings; and pipe sleeve extension, if any. Furnish pipe escutcheons with nickel or chrome finish for occupied areas, prime paint finish for unoccupied areas.

Pipe Escutcheons for Moist Areas: For waterproof floors, and areas where water and condensation can be expected to accumulate, provide cast brass or sheet brass escutcheons, solid or split hinged.

Pipe Escutcheons for Dry Areas: Provide sheet steel escutcheons, solid or split hinged.

2.2 DIELECTRIC FITTINGS

General: Provide standard products recommended by manufacturer for use in service indicated, which effectively isolate ferrous from non-ferrous piping (electrical conductance), prevent galvanic action, and stop corrosion.

Dielectric Unions: Provide dielectric unions on open systems where indicated on the Drawings.

Dielectric Waterway Fittings:

ASTM-A53 Zinc electroplated steel pipe casing with inert, non-corrosive thermoplastic lining (NSF/FDA listed).
Thread x thread ends 1/2-inch x 3-inch through 4-inch x 6-inch.
Groove x thread ends 1/2-inch x 4-inch through 4-inch x 6-inch.
Listed by IAPMO/UPC.
Dielectric unions are not an acceptable substitute for dielectric waterway fittings.

Dielectric Flange Insulation Kits:

Field-assembled, companion flange assembly, full face or ring type.
Neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
Provide separate companion flanges and steel bolts and nuts.
Rated at 175 psi conforming to ANSI B16.42 (iron) B16.24 (bronze).
Factory certified to withstand minimum of 600 volts on a dry line without flashover.
Meets federal specifications for tensile strength and thread end connections.

2.3 MECHANICAL SLEEVE SEALS

General: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

2.4 FIRE AND SMOKE BARRIER PENETRATION SEALS

General: Provide UL Listed firestopping systems composed of components that are compatible with each other, the substrates forming openings, and the items, if any, penetrating the firestopping under conditions of service and application, as demonstrated by the firestopping manufacturer based on testing and field experience.

Provide components for each firestopping system that are needed to install fill material. Use only components specified by the firestopping manufacturer and approved by the qualified testing agency for the designated fire-resistance-rated systems.

Penetrations in Fire Resistive Rated Walls: Provide firestopping with ratings determined in accordance with UL 1479 or ASTM E 814.

F-Rating: Not less than the fire-resistance rating of the wall construction being penetrated.

Penetration in Horizontal Assemblies: Provide firestopping with ratings determined in accordance with UL 1479 or ASTM E 814.

F-Rating: Minimum of 1-hour rating, but not less than the fire-resistance rating of the floor construction being penetrated.
T-Rating: When penetrant is located outside of a wall cavity, minimum of 1-hour rating, but not less than the fire-resistance rating of the floor construction being penetrated.
W-Rating: Class 1 rating in accordance with water leakage test per UL 1479.

Penetrations in Smoke Barriers: Provide firestopping with ratings determined in accordance with UL1479 or ASTM E 814.

L-Rating: Not exceeding 5.0 cfm/sq. ft. of penetration opening at both ambient and elevated temperatures.

2.5 FABRICATED PIPING SPECIALTIES

Drip Pans: Provide drip pans fabricated from corrosion-resistant sheet metal with watertight joints, and with edges turned up 2-1/2 inch, and with double sloped to drain bottom. Reinforce top, either by structural angles or by rolling top over 1/4-inch steel rod. Provide hole, gasket, and flange at low point for watertight joint and 1-inch drain line connection.

Drip pans shall be located under the drainage piping at the following locations, whether these areas have ceilings or not.

Operating Rooms
Delivery Rooms
Nurseries
Food Prep Centers
Food Serving Facilities
Food Storage Areas
Central Services (SPD)
Electronic Data Processing Areas
Electrical Closets
Other Sensitive Areas

Pipe Sleeves: Provide pipe sleeves of one (1) of the following:

Sheet Metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate from the following gauges: 3-inch and smaller, 20 gauge; 4-inch to 6-inch, 16 gauge; over 6-inch, 14 gauge.
Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe; remove burrs.
Iron Pipe: Fabricate from cast iron or ductile iron pipe; remove burrs.

Sleeve Seals: Provide sleeve seals for sleeves located in foundation walls below grade, or in exterior walls, of one (1) of the following:

Mechanical Sleeve Seals: Installed between sleeve and pipe.

PART 3 - EXECUTION

3.0 INSTALLATION OF PIPING SPECIALTIES

Pipe Escutcheons: Install pipe escutcheons on each pipe penetration through floors, walls, partitions, and ceilings where penetration is exposed to view; and on exterior of building. Secure escutcheon to pipe or insulation so escutcheon covers penetration hole, and is flush with adjoining surface.

Dielectric Unions: Install at each piping joint between ferrous and non-ferrous piping. Comply with manufacturer's installation instructions.

Mechanical Sleeve Seals: Loosely assemble rubber links around pipe with bolts and pressure plates located under each bolt head and nut. Push into sleeve and center. Tighten bolts until links have expanded to form watertight seal.

Fire or Fire/Smoke Barrier Penetration Seals: Where pipe penetration occurs in fire or fire/smoke rated walls, provide: a complete listed protection assembly equal to the rating of the wall/floor.

Provide dielectric waterways or insulating flanges, as required by pipe size, on all connections of dissimilar metals.

3.1 SLEEVES AND SEALS

Pipes:

Pipes:

New Construction: Pipes penetrating concrete or masonry construction, whether insulated or not, shall be provided with sheet metal or pipe sleeves fitted into place at time of construction. In poured concrete, the sleeves shall be steel pipe with a full circle, continuously welded water stop plate to also act as a sleeve anchor. When installing Link-Seal the sleeve and Link-Seal shall be of matched sizes. Otherwise, sleeves shall be of such size to provide all around clearance of 1/4-inch to 1-inch. Seal entire space between pipe and sleeve with fire stopping as specified in “Seals”.

Existing Construction: For existing construction or masonry construction, prepare pipe opening by carefully cutting or core drilling, install sheet metal sleeve, and fill any open space with material assembly equal to the listing of the wall. Cutting of concrete or masonry shall be done after approval of Structural Engineer.

Sleeves in non-fire rated or non-bearing walls, floors or ceilings, new or existing construction, shall be steel pipe or galvanized sheet metal with lock-type longitudinal seam. Pack all open spaces on each end with mineral wood or other non-combustible material, positively fastened in place. Asbestos is not acceptable.

Where a pipe of any description passes through a concrete floor, the sleeve shall extend at least 2-inch above the finished floor, except when using the ProSet Systems.

At Contractor's option, where uninsulated pipes penetrate cast-in-place concrete floors, the "ProSet Systems," Atlanta, Georgia, sleeving may be employed.

For pipes penetrating foundation walls, water-proofing membrane floors or other places where water leakage could be encountered, install Link-Seal wall sleeves by Thunderline Corporation in manner recommended by the manufacturer.

Where pipe penetrations occur in non-fire rated floors, roof slabs, or walls, the space between pipe insert and the sleeve shall be packed on each end with mineral wool or other non-combustible material, positively fastened in place. Use plenum rated caulk to seal packing around pipe.

Seals:

General:

Seal all holes or voids where mechanical systems penetrate fire rated floors and walls with a fire stopping sealant having a fire rating equal to or greater than that of the construction being penetrated. The sealant shall meet the requirements of ASTM E-814, ASTM E-119 and UL-1479. It shall be installed with strict adherence to the manufacturer's instructions and according to the product's UL Laboratory listing. The use of asbestos in any form is not permitted.

Conduct tests according to manufacturer’s written recommendations to verify that substrates are free of oil, grease, rolling compounds, incompatible primers, loose mill scale, dirt and other foreign substances capable of impairing bond of firestopping.

Do not cover firestopping with other construction until approval of authority having jurisdiction has been received.

Escutcheons:

In finished parts of the building, after painting is completed, install chromium plated escutcheons on all pipes passing through walls and floors where piping is exposed to view.

Flash and counterflash where mechanical equipment passes through weather or water-proofed walls, floors, and roofs per roof manufacturer's instructions.

Provide dielectric waterways or insulating flanges, as required by pipe size, on all connections of dissimilar metals.

3.2 INSTALLATION OF FABRICATED PIPING SPECIALTIES

Drip Pans: Locate drip pans under piping as indicated. Hang from structure with rods and building attachments, weld rods to sides of drip pan. Brace to prevent sagging or swaying. Connect 1-inch drain line to drain connection, and run to nearest plumbing drain or elsewhere as indicated.

Pipe Sleeves: Install pipe sleeves of types indicated where piping passes through walls, floors, ceilings, and roofs. Do not install sleeves through structural members of work, except as detailed on drawings, or as reviewed by Architect/Engineer. Install sleeves accurately centered on pipe runs. Size sleeves so that piping and insert will have free movement in sleeve, including allowance for thermal expansion; but not less than two (2) pipe sizes larger than piping run. Install length of sleeve equal to thickness of construction penetrated, and finish flush to surface; except floor sleeves. Extend floor sleeves in rooms 1/2-inch above level floor finish and 4-inch above finished floor in all Mechanical Equipment Rooms and pipe chases. Provide temporary support of sleeves during placement of concrete and other work around sleeves, and provide temporary closure to prevent concrete and other materials from entering sleeves.

Install sheet metal sleeves at interior partitions and ceilings other than suspended ceilings.
Install iron pipe sleeves at exterior penetrations; both above and below grade.
Install steel pipe sleeves except as otherwise indicated.

END OF SECTION 22 05 00

SECTION 22 05 16

PIPE EXPANSION JOINTS AND LOOPS FOR PLUMBING PIPING

PART 1 - GENERAL

1.0 DESCRIPTION OF WORK

Extent of Expansion Compensation Products required by this section is indicated on drawings and/or specified in other Division 23 sections.

Types of Expansion Compensation Products specified in this section include the following:

Packless Expansion Joints:

Externally Pressurized Bellows Expansion Joints
Bellows Expansion Joints
Expansion Compensators
Rubber Expansion Joints

Pipe Alignment Guides.

Expansion Compensation Products furnished as part of factory-fabricated equipment, are specified as part of equipment assembly in other Division 23 sections.

1.1 QUALITY ASSURANCE

Manufacturer's Qualifications: Firms regularly engaged in manufacture of expansion compensation products of types and sizes required, whose products have been in satisfactory use in similar service for not less than five (5) years.

Codes and Standards:

EJMA Compliance: Construct expansion compensation products in accordance with standards of the Expansion Joint Manufacturer's Association (EJMA).

1.2 SUBMITTALS

Product Data: Submit manufacturer's technical product data, including installation instructions for each type of expansion compensation product. Submit expansion compensation schedule showing manufacturer's figure number, size, location, and features for each required expansion compensation product.

Shop Drawings: Submit manufacturer's assembly-type shop drawings for each type of expansion compensation product, indicating dimensions, weights, required clearances, and methods of assembly of components.

Shop Drawings: Submit shop drawings for fabricated expansion loops indicating location, dimensions, pipe sizes, and location and method of attachment of anchors.

Maintenance Data: Submit maintenance data and spare parts lists for each type of expansion compensation product. Include this data, product data, and shop drawings in Maintenance Manual; in accordance with requirements of Division 1.

PART 2 - PRODUCTS

2.0 MANUFACTURERS

Manufacturer: Subject to compliance with requirements, provide products by one of the following:

Packless Expansion Joints Compensators:

- Flexonics Division; UOP, Inc.
- Hyspan Precision Products, Inc.
- Keflex, Inc.
- Metraflex Co.
- American BOA, Inc.

Packless Rubber Expansion Joints:

- Garlock; Mechanical Packing Division
- Mason Industries, Inc.
- Metraflex Co.

Pipe Alignment Guides:

- Hyspan Precision Products,Inc.
- Metraflex Co.
- Keyflex, Inc.

Slip Joints:

- Advanced Thermal Systems, Inc.
- Hyspan Precision Products, Inc.

Flexible Ball Pipe Joints:

- Advanced Thermal Systems, Inc.
- Barco Division, Marison Industries
- Gustin-Bacon Division; Aeroquip Corp.

Grooved Piping Couplings and Nipples Expansion Joints:

- Gustin-Bacon Division; Aeroquip Corp.
- ITT Grinnell
- Victaulic Co. of America

2.1 PIPE EXPANSION JOINTS, GENERAL

Pipe expansion joints shall provide 200 percent absorption capacity of calculated piping expansion between anchors.

2.2 PACKLESS EXPANSION JOINTS

General: Provide bellows expansion joints where indicated for piping systems, with materials and pressure/temperature ratings selected by manufacturer to suit intended service. Select expansion joints to provide 200 percent absorption capacity with 30 percent safety factor.

Bellows-Type Expansion Joints:

Externally Pressurized, Bellows-Type:

ASTM A240 T304 Stainless Steel laminated bellows.
Flanged Connections, conforming to ANSI B16.5.
Lifting lug.
Drain port.
150 psig design pressure.
Minimal warranted cycle life of 10,000 full-stroke cycles.
Internally guided.

Bellows-Type Expansion Joint:

ASTM A240 T304 Stainless Steel laminated bellows.
Flanged connections, conforming to ANSI B16.5.
150 psig design pressure.
Internal stainless steel liner.
Shouldered support of bellows to minimize stress at pipe-bellows weld.
External shroud
Minimum warranted life of 10,000 full-stroke cycles.

Expansion Compensators: Pressure rated for 100 psi for low-pressure systems and for 175 psi for high-pressure systems with a cycle life of 10,000 full-stroke cycles. Units shall have 2-ply phosphor bronze bellows, brass shrouds, and end fittings for copper piping systems and 2-ply stainless steel bellows, carbon steel shrouds, and end fittings for steel piping systems. Expansion compensators shall have internal guides and anti-torque device and removable end clip for proper positioning.

Provide Keflex Series 7Q; or Equal.

Rubber Expansion Joints: Fabric-reinforced butyl rubber with full-faced integral flanges, external control rods and shall be internally reinforced with steel retaining rings over entire surface of flanges, drilled to match flange bolt holes.

2.3 SLIP JOINTS

Slip Joints: Carbon steel slip type, designed for repacking under pressure. Slip joints shall have drip connections for steam piping systems and flanged or weld ends to mate with piping system. Packing shall be an asbestos-free compound.

2.4 FLEXIBLE BALL PIPE JOINTS

Joints shall be designed for 360 degree rotation and with minimum of 30 degree angular deflection for sizes 6-inches and smaller; 15 degree for sizes 8-inches and larger.

Joints shall be carbon steel and shall comply with Section II of ASME Boiler and Pressure Vessel Code and ASME B31.9 "Building Service Piping" for materials and design of pressure containing parts and bolting. Packing shall be asbestos-free composition.

Each assembly shall be factory tested with steam at working pressure of piping system for zero (0) leaks before shipment.

2.5 EXPANSION JOINTS FOR GROOVED PIPING

Combination Couplings and Nipples: Cut grooved short ASTM A 53 steel pipe nipples and ductile iron or malleable iron couplings, with removable ties to hold joint compressed or expanded during piping fabrication. Select suitable gasket materials for piping system.

Slip-Type Expansion Joints: Ductile iron or malleable iron housing, ASTM A 53 steel pipe body, and polytetrafluoroethylene (PTFE) modified polyphenylene coated steel pipe slide. Select suitable gasket material for piping system.

2.6 PIPE ALIGNMENT GUIDES

General: Provide pipe alignment guides at locations and spacing indicated. Construct with 4-finger spider traveling inside guiding sleeve, with provision for anchoring to concrete substrate.

Grinnell Fig. 256
Metraflex Style IV

PART 3 - EXECUTION

3.0 INSPECTION

Examine areas and conditions under which expansion compensation products are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.1 EXPANSION JOINTS

Install expansion joints where indicated, and elsewhere as determined by Installer for adequate expansion of installed piping system. Install in accordance with manufacturer's instructions. Provide pipe anchors and pipe alignment guides as indicated, and in accordance with manufacturer's recommendations. Align units properly to avoid end loading and torsional stress.

3.2 EXPANSION LOOPS

Fabricate expansion loops to dimensions indicated, in locations indicated, for adequate expansion compensation of installed piping system. Provide pipe anchors and pipe alignment guides as indicated, to properly anchor and align piping in relationship to expansion loops.

3.3 EXPANSION COMPENSATION FOR RISERS AND TERMINALS

Install connection between piping mains and risers with at least five (5) pipe fittings including tee in main. Install connections between piping risers and terminal units with at least four (4) pipe fittings, including tee in riser.

3.4 INSTALLATION OF PIPE ALIGNMENT GUIDES

Install pipe alignment guides on piping that adjoins expansion joints and elsewhere as indicated.

Anchor to building substrate.

END OF SECTION 22 05 16

SECTION 22 05 19

METERS AND GAUGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.0 DESCRIPTION OF WORK

Extent of Meters and Gauges required by this section is indicated on drawings and/or specified in other Division 22 sections.

Types of Meters and Gauges specified in this section include the following:

Temperature Gauges and Fittings:

- Glass Thermometers
- Solar/Light Powered Digital Thermometers
- Thermometer Wells

Pressure Gauges and Fittings:

- Pressure Gauges
- Pressure Gauge Cocks

Meters and gauges furnished as part of factory-fabricated equipment are specified as part of equipment assembly in other Division 22 sections.

1.1 QUALITY ASSURANCE

Manufacturer's Qualifications: Firms regularly engaged in manufacture of meters and gauges, of types and sizes required, whose products have been in satisfactory use in similar service for not less than five (5) years.

Codes and Standards:

UL Compliance: Comply with applicable UL Standards pertaining to meters and gauges.
ANSI and ISA Compliance: Comply with applicable portions of ANSI and Instrument Society of America (ISA) Standards pertaining to construction and installation of meters and gauges.
NSF Compliance: Construct and install thermometers and gauges in compliance with the lead-free requirements of NSF 61 Annex G and/or NSF 372.

Certification: Provide meters and gauges whose accuracies, under specified operating conditions, are certified by manufacturer.

1.2 SUBMITTALS

Product Data: Submit manufacturer's technical product data, including installation instructions for each type of meter and gauge. Include scale range, ratings, and calibrated performance curves, certified where indicated. Submit meter and gauge schedule showing manufacturer's figure number, scale range, location, and accessories for each meter and gauge.

All flow measuring devices to be provided shall be reviewed and approved by the Test and Balance Contractor for proper scale, rangeability and function prior to submitting shop drawings. The Test and Balance Contractor shall provide a typed letter stating this review has been completed and included with shop drawing submittals.

Maintenance Data: Submit maintenance data and spare parts lists for each type of meter and gauge. Include this data and product data in Maintenance Manual; in accordance with requirements of Division 1.

PART 2 - PRODUCTS

2.0 MANUFACTURERS

Manufacturer: Subject to compliance with requirements, provide products by one of the following:

Glass Thermometers:

- Miljoco Corp.
- Weiss Instruments, Inc.
- Dwyer
- Trerice
- Winters Instruments

Solar/Light Powered Digital Thermometers:

- Trerice
- Miljoco
- Weiss Instruments, Inc.
- Winters Instruments
- Dwyer

Thermometers and Wells:

- Miljoco Corp.
- Weiss Instruments, Inc.
- Trerice
- Winters Instruments
- Dwyer

Pressure Gauges, Snubbers and Pressure Gauge Cocks:

- Ametek/U.S. Gauge
- Miljoco Corp.
- Dwyer
- Trerice
- Winters Instruments

2.1 GLASS THERMOMETERS

General: Provide glass thermometers of materials, capacities, and ranges indicated, designed and constructed for use in service indicated.

Case: Die cast aluminum finished in baked epoxy enamel or powder coated, glass or acrylic lens front, spring secured, 9-inch long.

Adjustable Joint: Die cast aluminum, finished to match case, 180 degree adjustment in vertical plane, 360 degree adjustment in horizontal plane, with locking device.

Tube and Capillary: Non-Toxic spirit filled, 1 percent scale range accuracy, shock mounted.

Scale: Aluminum, white background with black graduations and markings.

Stem: Aluminum, or brass, for separable socket, length to suit installation.

Range: Conform to the following:

Hot Water: 30 Degree - 240 degree F with 2 degree F scale divisions (0 degree - 160 degree C with 2 degree C scale divisions).

2.2 SOLAR/LIGHT POWERED DIGITAL THERMOMETERS

General: Provide light-powered digital thermometers of materials, capacities, and ranges indicated, designed and constructed for use in service indicated.

Case and Solar Panels: Cast aluminum or high-impact ABS with LCD display powered by bi-directional solar panels.

Adjustable Joint: 180 degree adjustment in vertical plane, 360 degree adjustment in horizontal plane, with locking device.

Range: Field switchable temperature scale, -40 to 300 degrees F. (-40 to 150 degrees C.). Accuracy is 1 percent or 1 degree F., whichever is greater.

Stem: Aluminum or brass, for separable socket, length to suit installation.

Sensor: Glass passivated thermistor.

2.3 THERMOMETER WELLS

General: Provide thermometer wells constructed of lead-free brass certified to the requirements of NSF 372 or stainless steel, pressure rated to match piping system design pressure. Provide 2-inch extension for insulated piping. Provide cap nut with chain fastened permanently to thermometer well.

2.4 PRESSURE GAUGES

General: Provide pressure gauges of materials, capacities, and ranges indicated, designed and constructed for use in service indicated. All wetted parts in contact with water shall be certified to meet the requirements of NSF 372.

Type: General Use, 1 percent accuracy, ANSI B40.1 Grade A, phosphor bronze bourdon type, bottom connection.

Case: Stainless steel, drawn steel, cast aluminum or brass, glass lens, 4-1/2 inch diameter.

Connector: Brass with 1/4-inch male NPT.

Scale: White coated aluminum, with permanently etched markings.

Range: Conform to the following:

Vacuum: 30-Inch Hg - 15 PSI.
Water: 0 - 160 PSI.
Compressed Air: 0 – 300 PSI

2.5 PRESSURE GAUGE COCKS

General: Provide lead-free pressure gauge cocks between pressure gauges and gauge tees on piping systems. Construct gauge cock of brass with 1/4-inch female NPT on each end, and "T" handle brass plug.

Snubber: 1/4-Inch lead-free brass bushing with corrosion resistant porous metal disc, through which pressure fluid is filtered. Select disc material for fluid served and pressure rating.

PART 3 - EXECUTION

3.0 INSPECTION

Examine areas and conditions under which meters and gauges are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.1 INSTALLATION OF TEMPERATURE GAUGES

General: Install temperature gauges in vertical upright position, and tilted so as to be easily read by observer standing on floor.

Thermometer Wells: Install in piping tee where indicated, in vertical upright position. Fill well with oil or graphite, secure cap.

3.2 INSTALLATION OF PRESSURE GAUGES

General: Install pressure gauges in piping tee with pressure gauge cock, located on pipe at most readable position.

Locations: Install in the following locations, and elsewhere as indicated:

At suction and discharge of each pump.
At discharge of each pressure reducing valve.
At water service outlet.

Pressure Gauge Cocks: Install in piping tee with snubber.

All pressure gauges shall have isolation gauge cock, "snubber" valve, to service the gauge and isolate it from the pipe system service without having to drain the piping system.

For 6-Inch and Larger Piping Service, use ball valve for gauge isolation valve which shall be not less than 1/4-inch diameter for full gauge pipe correction diameter.

3.3 ADJUSTING AND CLEANING

Adjusting: Adjust faces of meters and gauges to proper angle for best visibility.

Cleaning: 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.

END OF SECTION 22 05 19

SECTION 22 05 23

GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.0 DESCRIPTION OF WORK

This Section includes potable cold, hot, and recirculated hot water valves within the building to a point 5-feet outside the building. This section includes the following:

Valves

1.1 QUALITY ASSURANCE

Regulatory Requirements: Comply with the provisions of the following:

Comply with ASME B16.10 and ASME B16.34 for Dimension and Design Criteria.
NSF Compliance: NSF 61 and NSF 372 for products that contact drinking water.
Local Plumbing Code and Utility Department requirements.
Montana Department of Environmental Quality
Safe Drinking Water Act – Public Law No. 111-380.

1.2 INSTALLER'S QUALIFICATIONS

All Plumbing Work shall be performed by a State of Montana Licensed Contractor under the supervision of a Licensed Plumber. Contractors shall verify that plumbers are currently licensed by the State of Montana and shall supply the Project Manager with names and license numbers. Contractors shall have a minimum of three (3) years of satisfactory performance in conducting the type of work specified.

1.3 SUBMITTALS

Submit under provisions of Division 1.

1.4 CLOSEOUT SUBMITTALS

Submit under provisions of Division 1.

Test Reports.

Valve schedule listing valve designation number, valve type, size, location, and function of all valves.

PART 2 - PRODUCTS

2.0 VALVES

General:

Valves shall be NSF/ANSI 61 and NSF/ANSI 372 compliant for potable-water service.
Valves for domestic water shall be 3rd Party Certified.
Comply with MSS-92 1980 "Valve Users Manual".
Sizes: Provide valves of same size as upstream pipe size.
Extended Stems: Where insulation is indicated or specified, provide extended stems to allow full operation of the valve without interference by the insulation.
Bypass and Drain Connections: Comply with MSS SP-45.

All valves shall be manufactured within the USA. No imported valves will be accepted. Documentation shall be provided with the submittal indicating compliance with the made in the USA requirement.

Gate Valves:

2-1/2 Inch and Larger: Lead-free, MSS-SP 70, 200 PSI CWP, non-rising stem, bolted bonnet, resilient wedge, NSF epoxy coated ASTM A126 Class B cast iron body or ASTM A536 ductile iron body, handwheel operator.

Acceptable Manufacturers:

Nibco
Watts
Wilkens

Ball Valves:

2-Inch and Smaller: MSS-SP-110, 100 PSI at 300°F, 600 PSI CWP, two-piece ASTM B-584 lead-free cast bronze body, full port, chrome plated brass/bronze ball, PTFE seats, anti-blowout stem, separate packnut with adjustable stem packing, extended stem, and vinyl covered steel handle. Threaded or soldered end connections. Valve shall be NSF/ANSI 61 and NSF/ANSI 372 compliant for potable-water service.

Acceptable Manufacturers:

Nibco
Milwaukee
Hammond

Check Valves:

Swing Check Valve:

2-1/2 Inch and Smaller: MSS SP-139 or MSS SP-80; pressure rating 200 CWP, ASTM B-584 lead-free bronze body and bonnet, horizontal swing design, Y-pattern, with PTFE seat disc. Threaded or soldered end connections. Valve shall be NSF 61 and NSF/ANSI 372 compliant for potable-water service.

Acceptable Manufacturers:

Nibco
Milwaukee
Hammond

3-Inch and Larger: MSS SP-71; Class 125, ASTM A126 Class B cast iron body with bronze trim, non-asbestos gasket, horizontal swing, and flanged ends. Valve shall be NSF 61 and NSF/ANSI 372 compliant for potable-water service.

Acceptable Manufacturers:

Nibco

Drain Valve: Lead-free bronze ball valve with threaded hose end and cap with chain. Valve upstream of backflow preventer shall have vacuum breaker and cap. MSS-SP-110, 600 PSI CWP, two-piece ASTM B-584 lead-free cast bronze body, full port, chrome plated brass/bronze ball, PTFE seats, anti-blowout stem, separate packnut with adjustable stem packing, extended stem, and vinyl covered steel handle. Threaded or soldered end connections. Valve shall be NSF/ANSI 61 and NSF/ANSI 372 compliant for potable-water service.

Acceptable Manufacturers:

Nibco
Milwaukee
Hammond

Calibrated Balancing Valves:

200 PSI, lead-free brass body, brass ball construction or stainless steel cartridge, with handle and memory stop. Differential pressure read-out ports across valve seat.

Acceptable Manufacturers:

Bell & Gossett ITT Circuit Setter CB Lead-free series
Griswold Controls – K Valve
Nexus Valve

PART 3 - EXECUTION

3.0 VALVES

Installation:

Use gate valves only on domestic water service entrances as specified by the Authority Having Jurisdiction.
Use ball valves for isolation valves unless noted otherwise.
Use ball valves for throttling or water meter bypass.
Use calibrated balancing valves for balancing valves.
Sectional Valves: Install sectional valves on each branch and riser, where branch or riser serves two (2) or more plumbing fixtures or equipment connections, and elsewhere as indicated.
Shutoff Valves: Install shutoff valves on inlet of each plumbing equipment item, and stops on inlet of each plumbing fixture, and elsewhere as indicated.
Drain Valves: Install drain valves at the base of each riser, at low points of horizontal runs, and elsewhere as required to completely drain distribution piping system.
Check Valves: Install check valves on discharge side of each pump, each side of reduced pressure backflow preventers and elsewhere as indicated.
Balancing Valves: Install in each hot water recirculating loop, discharge side of each pump, and elsewhere as indicated.
Chain Wheel Operators: For valves 2-1/2 inch and larger installed 96-inches or higher above finished floor elevation in mechanical rooms. Extend chains to an elevation of 6'-0" above finished floor elevation.

3.1 ADJUSTING AND CLEANING

Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

END OF SECTION 22 05 23

SECTION 22 05 29

HANGERS AND SUPPORTS FOR PLBG PIPING AND EQUIP

PART 1 - GENERAL

1.0 DESCRIPTION OF WORK

Extent of Supports and Anchors required by this section is indicated on drawings and/or specified in other Division 22 sections.

Types of Supports and Anchors specified in this section include the following:

- Horizontal-Piping Hangers and Supports
- Vertical-Piping Clamps
- Hanger-Rod Attachments
- Building Attachments
- Thermal Shield Inserts and Protective Shields
- Miscellaneous Materials
- Roof Equipment Supports
- Anchors
- Equipment Supports

Supports and anchors furnished as part of factory-fabricated equipment are specified as part of equipment assembly in other Division 22 sections.

1.1 QUALITY ASSURANCE

Manufacturer's Qualifications: Firms regularly engaged in manufacture of supports and anchors, of types and sizes required, whose products have been in satisfactory use in similar service for not less than five (5) years.

Codes and Standards:

Regulatory Requirements: Comply with applicable Plumbing Codes pertaining to product materials and installation of supports and anchors.

MSS Standard Compliance:

Provide pipe hangers and supports of which materials, design, and manufacture comply with MSS SP-58.

1.2 SUBMITTALS

Product Data: Submit manufacturer's technical product data, including installation instructions for each type of support and anchor. Submit pipe hanger and support schedule showing manufacturer's figure number, size, location, and features for each required pipe hanger and support.

Shop Drawings: Submit manufacturer's assembly-type shop drawings for each type of support and anchor, indicating dimensions, weights, required clearances, and methods of assembly of components.

Product certificates signed by the manufacturer of hangers and supports certifying that their products meet the specified requirements.

Maintenance Data: Submit maintenance data and parts list for each type of support and anchor. Include this data, product data, and shop drawings in maintenance manual; in accordance with requirements of Division 1.

PART 2 - PRODUCTS

2.0 MANUFACTURERS

Manufacturer: Subject to compliance with requirements, provide products by one of the following:

Pipe Hangers and Supports:

- B-Line Systems, Inc.
- Carpenter and Patterson, Inc.
- Fee & Mason Mfg. Co.; Division Figgie International
- PHD Manufacturing, Inc.
- Elcen Metal Products Company
- Erico/Caddy
- Unistrut Metal Framing Systems
- Hubbard Enterprises (Supports for domestic water piping)
- Hilti Construction Chemicals, Inc.
- Anvil

Thermal Shields:

- B-Line Systems, Inc.
- Pipe Shields, Inc.
- Insulation Pipe Supports Manufacturing
- Insulated Saddle Shield Insert Product Inc.
- Erico/Caddy
- Component Products Co.
- Value Engineered Products, Inc.
- Snappitz
- Anvil

Roof Pipe Supports:

- MAPA
- B-Line Systems, Inc.
- Roof Top Blox
- Miro Industries, Inc.
- Erico/Caddy

Concrete Inserts and Anchors:

- Phillips Drill Company
- Erico/Caddy
- Elcen Metal Products Company
- ITW Ramset/Red Head
- Hilti Construction Chemicals, Inc.
- B-Line Systems, Inc.
- Blue Banger Hanger

2.1 PIPE HANGERS AND SUPPORTS

Hangers and support components shall be factory fabricated of materials, design, and manufacturer complying with MSS SP-58.

Components shall have galvanized coatings where installed for piping and equipment that will not have field-applied finish.
Pipe attachments shall have nonmetallic coating for electrolytic protection where attachments are in direct contact with copper tubing.

Adjustable Clevis Hanger: MSS Type 1

Steel Pipe, size 3/8-inch thru 12-inch, B-Line B3100
Copper Pipe, size 1/2-inch thru 4-inch, B-Line B3104CT
Cast Iron Pipe, size 4-inch thru 24-inch, B-Line B3100

Adjustable Swivel Ring: MSS Type 10

Steel Pipe, size 1/2-inch thru 2-inch, B-Line B3170NF
Copper Pipe, size 1/2-inch thru 4-inch, B-Line B3170CT

Pipe Clamps: MSS Type 8

Steel Pipe, size 3/4-inch thru 20-inch, B-Line B3373
Copper Pipe, size 1/2-inch thru 4-inch, B-Line B3373CT

Floor Standpipe Saddle Support: MSS Type 37

Steel Pipe, size 1 1/2-inch thru 12-inch, B-Line B3095

Hanger Rods: Continuous threaded steel, sizes as specified.

Pipe Alignment Guides:

Pipe Guides: Provide factory-fabricated guides, of cast semi-steel or heavy fabricated steel, consisting of bolted two-section outer cylinder and base with two-section guiding spider bolted tight to pipe. Size guide and spiders to clear pipe and insulation (if any), and cylinder. Provide guides of length recommended by manufacturer to allow indicated travel.

Multiple or Trapeze: Structural steel channel (with web vertical), with welded spacers and hanger rods. Provide hanger rods one (1) size larger than for largest pipe in trapeze. If the deflection at center of trapeze exceeds 1/360 of the distance between the end hangers, install an additional hanger at mid-span or use a larger channel.

Wall Supports for Horizontal Pipe:

1/2-Inch thru 3-1/2 Inch: Steel offset hook.
4-Inch and Over: Welded steel bracket and wrought steel clamp.

Supports for Vertical Pipe: Steel or Copper Coated riser clamp.

Upper Attachments:

Beam Clamps:

All thread rod sized 3/8-inch and 1/2-inch, B-Line B3034
All thread rod sizes 5/8-inch, B-Line B3033
All thread rod sizes 3/4-inch and up, B-Line B3055

2.2 CONCRETE INSERTS AND ANCHORS

Inserts: Case shall be of galvanized carbon steel with square threaded concrete insert nut for hanger rod connection; 3/4-inch lateral adjustment; top lugs for reinforcing rods, nail holes for attaching to forms. Erico Hanger Models 355 and 355N or equal. This type of upper attachment is to be used for all areas having poured in place concrete construction.

Size inserts to suit threaded hanger rods.

Anchors: Carbon steel, zinc plated. Installation shall be in holes drilled with carbide-tipped drill bits or by use of self-drilling anchors.

Provide anchors suitable for the location of installation and designed to withstand all forces and movements acting in the anchor. Manufacture pipe anchors in accordance with MSS SP 58. Provide a safety factor of four (4) for the anchor installation.
Powder driven fasteners subject to approval of Structural Engineer. Each fastener shall be capable of holding a test load of 1,000 pounds whereas the actual load shall not exceed 50 pounds.
Self-drilling expansion shields. The load applied shall not exceed one-fourth the proof test load required.
Machine bolt expansion anchor. The load applied shall not exceed one-fourth the proof test load required.

2.3 THERMAL SHIELD INSERTS AND PROTECTIVE SHIELDS

General: Provide thermal shield inserts under all insulated piping hangers. Provide thermal shield inserts on all piping through floors, wall and roof construction penetrations. Size saddles and thermal shield inserts for exact fit to mate with pipe insulation or a minimum of 1-inch thick for uninsulated pipe thermal shield inserts.

Galvanized Protection Shields: MSS Type 40; of length recommended by manufacturer to prevent crushing of insulation. See also Part 3.H.3.

B-Line B3151

Thermal Shield Inserts: Provide 100-psi average compressive strength, waterproof, asbestos free calcium silicate, encased with galvanized steel protection shields or other listed system manufacturers. Insert and shield shall cover the entire circumference on vertical pipes, or the bottom half circumference of the pipe on horizontal mounting supports, and shall be of length recommended by the manufacturer for pipe size and thickness of insulation or the thickness of the wall, roof or floor construction.

NPS	Length	Metal Shield Thickness
1/4 thru 3-1/2	12	0.048
4	12	0.060
5 and 6	18	0.060

8 thru 14	24	0.075
16 thru 24	24	0.105

Thermal Mechanical Pipe Shields: Self-locking insulated pipe supports/shields shall be provided at hanger, support, and guide locations on pipe requiring insulation. The insert shall consist of either hydrous calcium silicate or polyisocyanurate foam insulation (urethane) encircling the entire circumference of the pipe with a 360 degree PVC or galvanized steel jacket which complies with the International Mechanical Code for installation in plenum ceilings where applicable. The length of the jacket shall be sized for pipe expansion.

2.4 MISCELLANEOUS MATERIALS

Steel Plates, Shapes, and Bars: ASTM A 36.

Cement Grout: Portland cement (ASTM C 150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C 404, Size No. 2). Mix ratio shall be 1.0 part cement to 3.0 parts sand, by volume, with minimum amount of water required for placement and hydration.

Heavy-Duty Steel Trapezes: Fabricate from steel shapes selected for loads required; weld steel in accordance with AWS Standards.

2.5 ROOF PIPE SUPPORTS

Factory fabricated roof support system for piping application. Base shall be compatible with roofing membrane. For support materials other than metal, such materials shall be UV resistant. All metal components shall be corrosion resistant by either galvanization or zinc plating.

Supports shall be designed to support the piping system and installed in accordance to manufacturer's requirements. The support shall have a continuous bottom surface to provide even load distribution and minimize point loading of the roof membrane. The support shall not require roof penetrations, flashing or damage to the roofing material.

Install with supplemental pad under support base as required by roofing system design.

PART 3 - EXECUTION

3.0 INSPECTION

Examine areas and conditions under which supports and anchors are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.1 PREPARATION

Proceed with installation of hangers, supports and anchors only after required building structural work has been completed in areas where the work is to be installed. Correct inadequacies including (but not limited to) proper placement of inserts, anchors and other building structural attachments.

Prior to installation of hangers, supports, anchors and associated work, Installer shall meet at Project Site with Contractor, installer of each component of associated work, inspection and testing agency representatives (if any), installers of other work requiring coordination with work of this section and Architect/Engineer for purpose of reviewing material selections and procedures to be followed in performing the work in compliance with requirements specified. Provide Shop Drawing showing method and support locations from structure.

3.2 INSTALLATION OF BUILDING ATTACHMENTS

Install building attachments within concrete or on structural steel. Space attachments within maximum piping span length indicated in MSS SP-69 and tables in this section. Install additional attachments at 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 to forms. Where concrete with compressive strength less than 2,500 psi is indicated, install reinforcing bars through openings at top of inserts.

New Construction:

Use inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams wherever practicable.
Set inserts in position in advance of concrete work. Provide reinforcement rod in concrete for inserts carrying pipe over 4-inch.
Where concrete slabs form finished ceiling, finish inserts flush with slab surface.
Use drop-in anchors for concrete structures.
Use beam clamps for steel structures.

3.3 INSTALLATION OF HANGERS AND SUPPORTS

Install hangers, supports, clamps and attachments to support piping properly from building structure; comply with MSS SP-69 and SP-89. Arrange for grouping of parallel runs of horizontal piping to be supported together on field fabricated, heavy-duty trapeze hangers where possible. Install supports with maximum spacings complying with MSS SP-69. Where piping of various sizes is supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping, and do not support piping from other piping.

Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers and other accessories.

Support fire-water piping independently from other piping systems.

Prevent electrolysis in support of copper tubing by use of hangers and supports which are copper plated, or by other recognized industry methods.

Install hangers and supports to allow controlled movement of piping systems, to permit freedom of movement between pipe anchors, to facilitate action of expansion joints, expansion loops, expansion bends and similar units and within 1'-0" of each horizontal elbow.

Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.

Pipe Slopes: Install hangers and supports to provide indicated pipe slopes, and so that maximum pipe deflections allowed by ANSI B31.9 Building Services Piping Code is not exceeded.

Install steel natural gas piping with the following minimum rod size and maximum spacing.

Size (NPS)(Inches)	Maximum Span in Feet	Minimum Rod Size - Inches
1/2	6	3/8
3/4 to 1-1/4	8	3/8
1-1/2 to 2	10	3/8
2-1/2 to 3	10	1/2
4 to 5	10	5/8
6 to 8	10	3/4
10 to 12	10	7/8
Vertical, all sizes	Every floor level	

Install horizontal water distribution piping with the following maximum hanger spacing and minimum rod sizes:

Nom. Pipe Size - Inches	Steel Pipe Max. Span - Feet	Copper Tube and DWV Copper Max. Span - Feet	Min. Rod Diameter - Inches
Up to 1/2	6	6	3/8
3/4 & 1	8	6	3/8
1-1/4	10	6	3/8
1-1/2	10	6	3/8
2	10	10	3/8
2-1/2	10	10	1/2
3	10	10	1/2
4	10	10	5/8
5	10	10	5/8
6	10	10	3/4
8	10	10	3/4

Install storm drains, sanitary drainage and vent systems with the following maximum spacing and minimum rod sizes:

Pipe Size	CAST IRON PIPE – HUB AND SPIGOT AND NO-HUB		
	Maximum Hanger Spacing (ft.)	Maximum Vertical Spacing (ft.)	Minimum Rod Size (in.)
1-1/4" to 2”	5	15	3/8
2-1/2" to 5”	5	15	1/2
6"	5	15	5/8
8" to 12”	5	15	3/4
14" to 16”	5	15	1
Based on MSS-69 & IPC. Provide midstory guides for piping 2 inches and smaller.			

Support horizontal cast iron pipe as follows:

Hub and Spigot: All sizes - One (1) hanger to each joint.
No-Hub: All sizes.

With ASTM C 1540 stainless steel couplings: One (1) hanger to each joint.
With all other stainless steel band type couplings: One (1) hanger to each side of joint.
Support all horizontal cast iron pipe within 18-inches of each joint and with 5-feet maximum spacing between hangers, except that pipe exceeding 5-feet in length shall be supported at intervals no greater than 10-feet.
Support vertical cast iron pipe at each story height and at its base. Secure vertical hub and spigot pipe immediately below the hub. Support vertical no-hub pipe so that the weight is carried from the pipe to the support and not from the joint to the support.

Provide copper or copper plated hangers and supports for copper piping.

Place a hanger within 1-foot (0.305 m) of each horizontal elbow.

Use hangers which are vertically adjustable 1-1/2 inch (38.1 mm) minimum after piping is erected.

Support vertical steel and copper piping at every story height but at not more than 15-foot intervals for steel and 10-feet for copper.

Where several pipes can be installed in parallel and at same elevation, provide trapeze hangers.

Support riser piping independently of connected horizontal piping.

All insulated pipes (≥ 2"d) shall have thermal shield insert at all support points. All piping shall have thermal shield inserts at each penetration through wall, floor and roof.

Each pipe drop to equipment shall be adequately supported. All supporting lugs or guides shall be securely anchored to the building structure.

Securely anchor and support plumbing domestic water piping in chases or walls. Use factory manufactured clamps and brackets connected to fixture carriers, waste/vent piping or brackets connected to studs. Wires or straps will not be permitted.

When copper supplies are connected to flush valves, support the tubing by the studs or by a fixture carrier, not by clamping to waste/vent piping.
Prevent copper tubes from making contact with steel brackets using fire retardant polyethylene inserts or other dielectric insulating material.
Place supports every 10-feet on vertical pipe and every 5-feet on horizontal pipe.

Hang all insulated pipe at the point of support in the following manner:

Hanger: See Paragraph 2.2.
Thermal Shield/Insert: Provide thermal shield insert of the same thickness as adjoining insulation for insulated pipe. The entire 360 degrees shall be waterproof, asbestos free, calcium silicate or polyisocyanurate foam insulation (urethane).

All hangers shall be properly sized to accommodate the thermal shield insert and no hanger shall penetrate or crush any of the insulating material.

Install anchors and fasteners in accordance with manufacturer's recommendations and the following:

In the event a self-drilling expansion shield or machine bolt expansion shield is considered to have been installed improperly, the Contractor shall make an acceptable replacement or demonstrate the stability of the anchor by performing an on-site test under which the anchor will be subjected to a load equal to twice the actual load.

Powder-driven fasteners may be used only where they will be concealed after the construction is complete. Where an occasional fastener appears to be improperly installed, additional fastener(s) shall be driven nearby (not closer than six (6) inches) in undisturbed concrete. Where it is considered that many fasteners are improperly installed, the Contractor shall test load any fifty (50) successively driven fasteners. If 10 percent or more of these fasteners fail, the Contractor shall utilize other fastening means as approved and at no additional cost to the Owner.

Hangers for piping shall be attached to cellular steel floor decks with steel plates and bolted rod conforming to the steel deck manufacturer's requirements. Where the individual hanger load exceeds the capacity of a single floor deck attachment, steel angles, beams or channels shall be provided to span the number of floor deck attachments required.

Welding may be used for securing hangers to steel structural members. Welded attachments shall be designed so that the fiber stress at any point of the weld or attachment will not exceed the fiber stress in the hanger rod.

3.4 INSTALLATION OF ANCHORS

Install anchors at proper locations to prevent stresses from exceeding those permitted by ANSI B31.9, and to prevent transfer of loading and stresses to connected equipment.

Fabricate and install anchor by welding steel shapes, plates and bars to piping and to structure. Comply with ANSI B31.9 and with AWS Standards D1.1.

Where expansion compensators are indicated, install anchors in accordance with expansion unit manufacturer's written instructions, to control movement to compensators.

Anchor Spacings: Where not otherwise indicated, install anchors at ends of principal pipe-runs, at intermediate points in pipe-runs between expansion loops and bends. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.

3.5 EQUIPMENT SUPPORTS

Fabricate structural steel stands to suspend equipment from structure above or support equipment above floor.

Grouting: Place grout under supports for piping and equipment.

Concrete bases for the mechanical equipment indoors or outdoors will be provided by the General Contractor only if shown on the Architectural or Structural Drawings. Otherwise, all bases shall be provided by this Contractor.

Housekeeping bases shall be 4-inch thick minimum, extended 4-inch beyond machinery bedplates.

This Contractor shall be responsible for the proper size and location of all bases and shall furnish all required anchor bolts and sleeves. If bases are provided by the General Contractor, furnish him with templates showing the bolt locations.

Equipment shall be secured to the bases with anchor bolts of ample size. Bolts shall have bottom plates and pipe sleeves and shall be securely imbedded in the concrete. All machinery shall be grouted under the entire bearing surface. After grout has set, all wedges, shims and jack bolts shall be removed and the space filled with non-shrinking grout. This Contractor shall provide washers at all equipment anchor bolts.

Construct equipment supports above floor of structural steel members or steel pipe and fittings. Brace and fasten with flanges bolted to structure.

Provide rigid anchors for pipes immediately after vibration connections to equipment.

3.6 METAL FABRICATION

Cut, drill, and fit miscellaneous metal fabrications for pipe anchors and equipment supports. Install and align fabricated anchors in indicated locations.

Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

Field Welding: Comply with AWS D1.1 for procedures of manual shielded metal-arc welding, appearance and quality of welds made, methods used in correcting welding work, and the following:

Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
Obtain fusion without undercut or overlap.
Remove welding flux immediately.
Finish welds at exposed connections so that no roughness shows after finishing.

3.7 ADJUSTING

Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

Touch-Up Painting: Immediately after erection of anchors and supports, clean field welds and abraded areas of shop paint and paint exposed areas with same material as used for shop painting to comply with SSPC-PA-1 requirements for touch-up of field-painted surfaces.

Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils.

For galvanized surfaces, clean welds, bolted connections and abraded areas and apply galvanizing repair paint to comply with ASTM A 780.

END OF SECTION 22 05 29

SECTION 22 05 53

IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.0 DESCRIPTION OF WORK

Extent of Mechanical Identification Work required by this section is indicated on drawings and/or specified in other Division 22 sections.

Types of Identification Devices specified in this section include the following:

- Painted Identification Materials
- Plastic Pipe Markers
- Plastic Tape
- Underground-Type Plastic Line Marker
- Valve Tags
- Valve Schedule Frames
- Engraved Plastic-Laminate Signs
- Plasticized Tags
- Lettering and Graphics

Refer to Division 26 sections for Identification Requirements of Electrical Work; not work of this section.

1.1 QUALITY ASSURANCE

Manufacturer's Qualifications: Firms regularly engaged in manufacturer of identification devices of types and sizes required, whose products have been in satisfactory use in similar service for not less than five (5) years.

Codes and Standards:

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

1.2 SUBMITTALS

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

Schedules: Submit valve schedule for each piping system, typewritten and reproduced on 8-1/2" x 11" bond paper. Tabulate valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), size of valve, and variations for identification (if any). Only tag valves which are intended for emergency shutoff and similar special uses, such as valve to isolate individual system risers, individual floor branches or building system shut-off valves. In addition to mounted copies, furnish extra copies for Maintenance Manuals as specified in Division 1.

PART 2 - PRODUCTS

2.0 MANUFACTURERS

Manufacturer: Subject to compliance with requirements, provide products by one of the following:

Allen Systems, Inc.
Brady (W.H.) Co.; Signmark Division
Brimar Industries, Inc.
Industrial Safety Supply Co., Inc.
Seton Name Plate Corp.

2.1 MECHANICAL IDENTIFICATION MATERIALS

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

2.2 PAINTED IDENTIFICATION MATERIALS

Stencils: Standard fiberboard stencils, prepared for required applications with letter sizes generally complying with recommendations of ANSI A13.1 for piping or to match existing size in existing building, but not less than 3/4-inch high letters for access door signs and similar operational instructions.

Stencil Paint: Standard exterior type stenciling enamel; Black, except as otherwise indicated; either brushing grade or pressurized spray-can form and grade.

Identification Paint: Standard identification enamel of colors indicated or, if not otherwise indicated, comply with ANSI A13.1 for colors or to match existing building standard identification.

2.3 PLASTIC PIPE MARKERS

Snap-On Type: Provide manufacturer's standard pre-printed, semi-rigid snap-on, color-coded pipe markers, complying with ANSI A13.1.

Insulation: Furnish 1-inch thick molded fiberglass insulation with jacket for each plastic pipe marker to be installed on uninsulated pipes subjected to fluid temperatures of 125 degree F (52 degree C) or greater. Cut length to extend 2-inch beyond each end of plastic pipe marker.

Small Pipes: For external diameters less than 6-inch (including insulation if any), provide full-band pipe markers, extending 360 degrees around pipe at each location, fastened by one (1) of the following methods:

Snap-on application of pre-tensioned semi-rigid plastic pipe marker.
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 inch.

Large Pipes: For external diameters of 6-inch and larger (including insulation if any), provide either full-band or strip-type pipe markers, but not narrower than three (3) times letter height (and of required length), fastened by one (1) of the following methods:

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

Strapped-to-pipe (or insulation) application of semi-rigid type, with manufacturer's standard stainless steel bands.

Lettering: Comply with piping system nomenclature as specified, scheduled, shown, or to match existing building lettering nomenclature system and abbreviate only as necessary for each application length.

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.

2.4 PLASTIC TAPE

General: Provide manufacturer's standard color-coded pressure-sensitive (self-adhesive) vinyl tape, not less than 3 mils thick.

Width: Provide 1-1/2 inch wide tape markers on pipes with outside diameters (including insulation, if any) of less than 6-inch, 2-1/2 inch wide tape for larger pipes.

Color: Comply with ANSI A13.1, except where another color selection is indicated.

2.5 UNDERGROUND-TYPE PLASTIC LINE MARKERS

General: Manufacturer's standard permanent, bright-colored, continuous-printed plastic tape, intended for direct-burial service; not less than 6-inch wide x 4 mils thick. Provide tape with printing which most accurately indicates type of service of buried pipe.

Provide multi-ply tape consisting of solid aluminum foil core between 2-layers of plastic tape.

2.6 VALVE TAGS

Brass Valve Tags: Provide 19-gauge polished brass valve tags with stamp-engraved piping system abbreviation in 1/4-inch high letters and sequenced valve numbers 1/2-inch high, valve normal position 1/4-inch high letters, and with 5/32-inch hole for fastener.

Provide 1-1/2 inch diameter tags, except as otherwise indicated.
Fill tag engraving with Black enamel.

Valve Tag Fasteners: Provide manufacturer's standard solid brass chain (wire link or beaded type), and solid brass S-hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.

Access Panel Markers: Provide manufacturer's standard 1/16-inch thick engraved plastic laminate access panel markers, with abbreviations and numbers corresponding to concealed valve. Include 1/8-inch center hole to allow attachment.

2.7 VALVE SCHEDULE

Valve Schedule shall be printed on company letterhead and shall include the following columns:

Valve Tag Number (*example*: HWS-1)
Service (*example*: ISOLATE AHU-1 HEATING COIL)
Room Number (location of valve)
Size of Valve
Type of Valve
Normal Position of the Valve (open or closed)

Frame: For each page of valve schedule, provide glazed display frame, with screws for removable mounting on masonry walls. Provide frames of finished hardwood or extruded aluminum, with non-glare type plexiglass.

2.8 PLASTICIZED TAGS

General: Manufacturer's standard pre-printed or partially pre-printed accident-prevention tags, of plasticized card stock with matt finish suitable for writing, approximately 3-1/4 inch x 5-5/8 inch, with brass grommets and wire fasteners, and with appropriate pre-printed wording including large-size primary wording (As examples; DANGER, CAUTION, DO NOT OPERATE).

2.9 LETTERING AND GRAPHICS

General: Coordinate names, abbreviations and other designations used in mechanical identification work, with corresponding designations shown, specified, scheduled and approved by the Owner/Engineer. Provide numbers, lettering and wording as indicated and approved by the Owner/Engineer for proper identification and operation/maintenance of mechanical systems and equipment.

Multiple Systems: Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as designated on the drawings or schedule as well as service.

PART 3 - EXECUTION

3.0 GENERAL INSTALLATION REQUIREMENTS

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.

3.1 PIPING SYSTEM IDENTIFICATION

General: Install pipe markers of the following type on each system indicated to receive identification, and include arrows to show normal direction of flow.

Plastic pipe markers, with application system as indicated under "MATERIALS" in this section. Install on pipe insulation segment where required for hot non-insulated pipes.

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

Near each valve and control device.

Near each branch, excluding short take-offs for fixtures; mark each pipe at branch, where there could be question of flow pattern.

Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures.

At access doors, manholes and similar access points which permit view of concealed piping.

Near major equipment items and other points of origination and termination.

Spaced intermediately at maximum spacing of 25-foot along each piping run, except reduce spacing to 15-foot in congested areas of piping and equipment.

On piping above removable acoustical ceilings.

3.2 UNDERGROUND PIPING IDENTIFICATION

General: During back-filling/top-soiling of each exterior underground piping systems, install continuous underground-type plastic line marker, located directly over buried line at 6-inch to 8-inch below finished grade. Where multiple small lines are buried in common trench and do not exceed overall width of 16-inch, install single line marker. For tile fields and similar installations, mark only edge pipelines of field.

3.3 VALVE IDENTIFICATION

General: Provide valve tag on valves in each piping system. List each tagged valve in valve schedule for each piping system.

Building services main shutoff valves.
Each individual system main shutoff valves.
Each individual system riser shutoff valves.
Each individual system floor shutoff valves.
Each individual system major branch shutoff valves.

Provide the following columns and information for each valve:

Valve Tag Number (*example*: HWS-1)
Service (*example*: ISOLATE AHU-1 HEATING COIL)
Room Number (location of valve)
Size of Valve
Type of Valve
Normal Position of the Valve (open or closed)

Mount valve schedule frames and schedules in mechanical equipment rooms where directed by Architect/Owner/Engineer.

Where more than one (1) major mechanical equipment room is shown for project, install mounted valve schedule in each major mechanical equipment room, and repeat only main valves which are to be operated in conjunction with operations of more than single mechanical equipment room.

3.4 MECHANICAL EQUIPMENT IDENTIFICATION

General: Install minimum 2-inch x 4-inch engraved plastic laminate equipment marker on each individual items of mechanical equipment. Provide signs for the following general categories of equipment.

Main building systems control and operating valves, including safety devices and hazardous units such as gas outlets.
Fuel-burning units including boilers, water heaters, medical gas equipment.
Pumps, and similar motor-driven units.
Heat exchangers, and similar equipment.
Tanks and pressure vessels.
Water treatment systems and similar equipment.

Lettering Size: Minimum 1/4-inch high lettering for name of unit.

Text of Signs: In addition to the identified unit, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.

3.5 ADJUSTING AND CLEANING

Adjusting: Relocate any mechanical identification device which has become visually blocked by work of this division or other divisions.

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

END OF SECTION 22 05 53

SECTION 22 07 00
PLUMBING INSULATION

PART 1 - GENERAL

1.0 DESCRIPTION OF WORK

This Section includes:

Piping Insulation, Jackets and Accessories
Equipment Insulation and Covering

Refer to other Division 22 sections for Shields, Inserts, and Mechanical Identification.

1.1 QUALITY ASSURANCE

Manufacturer's Qualifications: Firms regularly engaged in manufacture of mechanical insulation products, of types and sizes required, whose products have been in satisfactory use in similar service for not less than three (3) years.

Installer's Qualifications: Firm with at least five (5) years successful installation experience on projects with mechanical insulations similar to that required for this project.

Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics and insulating cements.

1.2 SUBMITTALS

Product Data: Submit manufacturer's installation instructions and schedule listing materials, thickness, K-value, density, and furnished accessories for each service or equipment specified.

1.3 DELIVERY, STORAGE, AND HANDLING

Deliver insulation, coverings, cements, adhesives, and coatings to site in containers with manufacturer's stamp or label, affixed showing fire hazard ratings of the products, name of manufacturer, and brand.

Protect insulation against dirt, water, chemical, and mechanical damage.

PART 2 - PRODUCTS

2.0 MANUFACTURERS

Manufacturer: Subject to compliance with requirements, provide product by one of the following:

Insulation:

Armstrong World Industries, Inc. (flexible elastomeric)
Johns-Manville Products Corp. (fiberglass, calcium silicate)
Knauf Fiber Glass (fiberglass)
Manson Insulation Co. (fiberglass, calcium silicate)
Owens-Corning Fiberglas Corp. (fiberglass)
Rubatex Corp. (flexible elastomeric)
Aeroflex (flexible elastomeric)

Roxul (Mineral Wool)

Jacketing, Coatings, Adhesives, Sealants and Covering Products:

Childers
Foster
Ceel-Co.
Johns-Manville Products Corp.
Knauf Fiber Glass
Venture Tape Corporation
Design Polymetrics
PIC Plastics

2.1 PIPING INSULATION

Glass Fiber: ASTM C 547, Type 1, rigid molded, noncombustible, 0.23 "K" value at 100 degree F mean temperature, maximum service temperature 850 degree F, moisture sorption less than 0.2% by volume. Composite 25/50-flame spread/smoke developed rating (ASTM E 84, UL 723, and NFPA 255).

Vapor Retarder Jacket: ASTM C 1136, 45lbs/in tensile strength (ASTM D 828), or beach puncture 50 oz in/in tear minimum (ASTM D 781). White Kraft paper reinforced with glass fiber yarn and bonded to aluminum foil, secured with self-sealing longitudinal laps and butt strips.

Connections: Tacks, pressure sensitive color matching vinyl tape, Perma-Weld adhesive.

Calcium Silicate: ASTM C 533, Type I, rigid molded, noncombustible (ASTME E 136), 0.42 "K" value at 300 degree F mean temperature, maximum service temperature 1200 degree F, 160 psi compressive strength for 5 percent compression (ASTM C 165), flexural strength 70 psi (ASTM C 203). 0/0 flame spread/smoke developed rating (ASTM E 84).

Tie Wire: 16-Gauge stainless steel with twisted ends on maximum 12-inch centers.

Flexible Elastomeric Foam: ASTM C 534, Type I, flexible, cellular elastomeric, molded, 0.27 "K" value at 75 degree F mean temperature, maximum service temperature 220 degree F, water vapor permeability of 0.10 perm-inch, 25/50-flame spread/smoke developed rating (ASTM E 84, UL 723, and NFPA 255).

Field Applied Fittings and Jackets:

PVC Plastic:

One-piece, gloss white, molded fitting covers with factory installed fiberglass insulation inserts.
20 Mil (30 mil for exterior applications) cut and curled gloss white jacketing material. Composite 25/50 flame spread/smoke developed rating (ASTM E84).
Connect with tacks and pressure sensitive color matching vinyl tape.

Canvas: UL Listed fabric, 6 oz/sq yd, plain weave cotton treated with dilute fire retardant lagging adhesive. Foster 30-36, Childers CP-50AMV1 or Duct Mate Lag it.
Aluminum: 0.016-Inch thick sheet with factory applied moisture barrier, with longitudinal slip joints and 2-inch laps, die shaped fitting covers.
Stainless Steel: Type 304 stainless steel, 0.010-inch.

2.2 EQUIPMENT INSULATION

Rigid Fiberglass Board (Low Temperature): ASTM C 612, Type IA and IB, 3 lb/cu ft density, 0.23 "K" value at 75 degree F mean temperature, maximum service temperature 450 degree F, moisture sorption less than 5.0% by weight, aluminum foil facing reinforced with fiberglass scrim laminated to UL rated Kraft paper. Composite 25/50-flame spread/smoke developed rating (ASTM E 84, UL 723, and NFPA 90A).

Secure with UL Listed pressure sensitive tape and/or outward clinched expanded staples and vapor barrier mastic as needed.

Rigid Fiberglass Board (High Temperature): ASTM C 612, Type II, 3 lb/cu ft density, 0.23 "K" value at 75 degree F mean temperature, maximum service temperature 850 degree F, moisture sorption less than 5.0% by weight, 1-inch galvanized hexagonal wire mesh facing stitched on face of insulation. Composite 25/50-flame spread/smoke developed rating (ASTM E 84, UL 723, and NFPA 90A).

Secure with UL listed pressure sensitive tape and/or outward clinched expanded staples and vapor barrier mastic as needed.

Calcium Silicate: ASTM C 533, Type I, rigid molded block, noncombustible (ASTME E 136), 0.41 "K" value at 300 degree F mean temperature, maximum service temperature 1200 degree F, 160 psi compressive strength for 5 percent compression (ASTM C 165), flexural strength 70 psi (ASTM C 203). 0/0 flame spread/smoke developed rating (ASTM E 84).

Banded in place, tightly butted, joints staggered and secured with 16 gauge galvanized or stainless steel wire or 1/2-inch x 0.015-inch galvanized steel bands on 12-inch maximum centers for large areas.

Jacketing Material for Equipment Insulation: Provide pre-sized glass cloth jacketing material, not less than 7.8 ounces per square yard, or metal jacket at Installer's option, except as otherwise indicated.

Equipment Insulation Accessories: Provide staples, bands, wire, wire netting, tape, corner angles, anchors and stud pins as recommended by insulation manufacturer for applications indicated.

Equipment Insulation Coatings, Mastics and Adhesives:

Vapor Barrier Coating (Store and apply between 40° F and 100°F, protect from freezing until dry): Used on below ambient piping/duct to prevent moisture ingress. Permeance shall be 0.013 perms or less at 43 mils dry per ASTM E 96, Procedure B.

Foster 30-80
Childers CP-38
Vimasco 749

Weather Barrier Mastic (Store and apply between 40° F and 100° F, protect from freezing until dry): Used on above ambient piping/duct outdoors.

Fosters 46-50
Childers CP-10/11
Vimasco WC-5

Lagging Adhesive/Coating (Store and apply between 40° F and 100° F, protect from freezing until dry): Comply with MIL-A-3316C, Class 1, Grade A.

Foster 30-36
Childers CP-50AHV2
Vimasco 713

Fiberglass Adhesive (Store and apply between 40° F and 100° F, protect from freezing until dry): Comply with ASTM C916, Type II.

Foster 85-60
Childers CP-127
Vimasco 795

Metal Jacketing/Flashing Sealant (Store and apply between 40° F and 100° F, protect from freezing until dry): Used to seal metal jacketing laps against water entry and to flash penetrations.

Foster 95-44
Childers CP-76
Pittsburgh Corning PC 727

Reinforcing Mesh: Used in conjunction with coatings and mastics.

Foster Mast a Fab
Childers Chil Glas #10
Vimasco Elast a Fab

PART 3 - EXECUTION

3.0 INSPECTION

Examine areas and conditions where mechanical insulation is to be installed. Do not proceed until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.1 PLUMBING PIPING INSULATION

Cold Piping:

Applications:

Potable and non-potable cold water.
Potable chilled water.
Interior aboveground storm water.
Interior above ground overflow storm piping within six (6) lineal feet of roof bowl.
Plumbing vents within six (6) lineal feet of roof outlet.
Roof and overflow drain bowls.

Insulation:

Fiberglass: 1/2-Inch thickness up to 1-1/4 inch pipe size, 1-inch thickness for 1-1/2 inch pipe size and larger.

Hot Piping:

Applications:

Potable hot water.
Potable hot water and hot water circulation.
Hot equipment drain.

Insulation:

Hot water and circulating water; Fiberglass: Piping insulation shall be 1-inch thickness for pipes up to and including 1 1/4 inch and 1 1/2 inch for all other sizes.

3.2 EQUIPMENT INSULATION

Cold Equipment (Below Ambient Temperature):

Applications:

Cold water storage tanks.
Water softeners.
Expansion tanks.

Insulation:

Flexible Fiberglass Blanket: 1-1/2 Inch thickness.

Hot Equipment (Above Ambient Temperature):

Applications:

Boiler surfaces not factory insulated.
Hot water storage tanks.
Water heater surfaces not factory insulated.
Heat exchangers.
Hot water expansion tanks.

Insulation:

Fiberglass (High Temperature): 2-Inch thickness, except 3-inch thickness for low-pressure boilers and steam-jacketed heat exchangers. Do not use for equipment above 450 degree F (232 degree C).
Calcium Silicate: 2-Inch thickness, except 3-inch thickness for low-pressure boilers and steam-jacketed heat exchangers.

3.3 INSTALLATION OF PIPING INSULATION

Install insulation after piping system tests have been completed.

Clean piping to remove foreign substances and moisture prior to applying insulation.

Install insulation products according to manufacturer's written instructions, building codes, and recognized industry standards.

Omit insulation on exposed chrome-plated piping (except for handicapped fixtures), air chambers, unions, balance cocks, flow regulators, drain lines from water coolers, drainage piping located in crawl spaces or tunnels, buried piping, fire protection piping, and pre-insulated equipment.

Secure longitudinal jacket laps and butt strips according to manufacturer's recommendations.

Firmly rub lap and butt strips to pressurize seam and ensure positive closure.

Insulate each continuous run of piping with full-length units of insulation, with single cut piece to complete run. Do not use scraps.

Apply insulation to piping with all joints tightly fitted to eliminate voids.

Apply insulation on cold surfaces with a continuous, unbroken vapor seal. Hangers, supports, and anchors that are secured directly to cold surfaces must be adequately insulated and vapor sealed to prevent condensation.

Extend surface finishes to protect all surfaces, end, and raw edges of insulation.

Protect vapor-barrier jackets on pipe insulation from puncture or other damage. Avoid the use of staples on vapor barrier jackets. Seal vapor barrier penetrations with vapor barrier coating.

Cover valves, fittings and similar items with equivalent thickness and composition of insulation as applied to adjoining pipe run. Install factory molded or job fabricated covers (at Installer's option). Coat all below ambient valves, fittings and similar items with vapor barrier coating and reinforcing mesh before application of PVC covers.

Extend piping insulation without interruption through walls, floors and similar piping penetrations, except where fire-stopping materials are required.

Provide thermal shield inserts on all pipe (Refer to 220529). For piping below ambient temperature, apply vapor barrier lap cement on butt joints and seal with 3-inch wide vapor barrier tape.

Minimum insulation insert lengths:

1-1/2 – 2-1/2 Inch Pipe: 10-Inches
3 – 6-Inch Pipe: 12-Inches
8 – 10-Inch Pipe: 16-Inches
12-Inch and Larger Pipe: 22-Inches

Apply galvanized metal shields between hangers or supports and pipe insulation. Form shields to fit the insulation and extend up to the centerline of the pipe. The shield length shall be 4-inches less than the associated insulation hanger insert to allow for vapor retarding butt joints on each side of the shields.

Apply adhesives, mastics and coatings at manufacturer's recommended minimum coverage per gallon.

Replace all damaged insulation in whole; Repair of damaged insulation will not be accepted.

Insulate fittings and valves with PVC insulated fitting covers and insulation inserts per manufacturer's recommendations.

3.4 INSTALLATION OF EQUIPMENT INSULATION

Install insulation products according to manufacturer's instructions, building codes, and recognized industry standards.

Apply insulation as close as possible to equipment by grooving, scoring, and beveling insulation, if necessary. As required, secure insulation to equipment with studs, pins, clips, adhesive, wires, or bands

Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment use vapor retardant cement

Provide insulated dual temperature or cold equipment containing fluids below ambient temperature with vapor retardant jackets

Maintain integrity of vapor-barrier on equipment insulation and protect it to prevent puncture and other damage.

Do not apply insulation to equipment, mufflers, breechings, or stacks while hot.

Apply insulation using staggered joint method and double layer construction. Apply each layer of insulation separately.

Cover insulated surfaces with all-service jacketing neatly fitted and firmly secured. Lap seams at least 2-inch. Apply over vapor barrier where applicable.

Do not insulate manholes, handholes, cleanouts, ASME stamp, or manufacturer's nameplate. Provide neatly beveled edge at interruptions of insulation.

Provide removable insulation sections with aluminum jacket and stainless steel bands to cover parts of equipment which must be opened for maintenance; include metal vessel covers, fasteners, flanges, frames and accessories.

Provide aluminum jacketing on exterior insulated equipment as recommended by manufacturer.

3.5 EXISTING INSULATION REPAIR

Repair damaged sections of existing mechanical insulation, both previously damaged or damaged during this construction period.

END OF SECTION 22 07 00

SECTION 22 11 16

DOMESTIC WATER PIPING

PART 1 - GENERAL

1.0 DESCRIPTION OF WORK

This Section includes potable cold, hot, and recirculated hot water piping, fittings, and specialties within the building to a point 5-feet outside the building. This section includes the following:

Pipe and Tube Materials:

Above Grade, inside buildings.
Below Grade, inside buildings.

1.1 DEFINITIONS

Water Distribution Piping: A pipe within the building or on the premises, which conveys water from the water service pipe or meter to the points of usage.

Water Service Piping: The pipe from the water main or other source of potable water supply to the water distributing system of the building served.

1.2 QUALITY ASSURANCE

Regulatory Requirements: Comply with the provisions of the following:

ASME B 31.9 "Building Services Piping" for materials, products and installation. Safety valves and pressure vessels shall bear the appropriate ASME label.
ASME "Boiler and Pressure Vessel Code", Section IX, "Welding and Brazing Qualification" for Qualifications for Welding Processes and Operators.
Comply with ANSI B31 Code for Pressure Piping.
Local Plumbing Code and Utility Department requirements.
Comply with NSF 61: Drinking Water System Components - Health Effects; Sections 1 through 9," For Potable Domestic Water Piping and Components; NSF 61 Annex G or NSF 372.
Montana Department of Environmental Quality
Safe Water Drinking Act – Including Public Law 111-380 – Cited as the “Reduction of Lead in Drinking Water Act”.

All piping systems shall be installed to manufacturer's standards and in accordance with the pipe manufacturer's instructions. Contractor shall demonstrate prior to installation of any piping that joining methods and procedures are acceptable to the Engineer and/or Owner with the Factory Representative present. During the installation of the piping system, the Contractor shall be required to provide joint coupons as requested by the Owner or Engineer and repair and/or replace system if joints are deemed unsatisfactory.

1.3 INSTALLER'S QUALIFICATIONS

All Plumbing Work shall be performed by a State of Montana Licensed Contractor under the supervision of a Licensed Plumber. The General Contractor shall verify that plumbers are currently licensed by the State of Montana Plumbing Contractors shall have a minimum of three (3) years of satisfactory performance in conducting the type of work specified.

1.4 SUBMITTALS

Submit under provisions of Division 1.

1.5 CLOSEOUT SUBMITTALS

Submit under provisions of Division 1.

Test Reports.

PART 2 - PRODUCTS

2.0 MANUFACTURERS

Available Manufacturers:

Pipe and Fittings:

Charlotte Pipe and Foundry
Nibco

2.1 PIPE AND TUBE MATERIALS

Above Grade Inside Buildings:

Pipe 4-Inch and Smaller: ASTM B 88; Type L lead-free hard drawn copper tube.

Fittings:

Lead-Free Wrought Copper Solder-Joint Fittings: ASME B16.22.
Lead-Free Cast Copper Solder-Joint Fittings: ASME B16.18.
Lead-Free Cast Copper Alloy Flanges Class 150 and 300, Flat-Face Type: ASME B16.24.
Contractor Option: Mechanical Pressure-Seal fittings shall be lead-free. Fitting shall be press type with EPDM sealing elements. Contractor shall order valves and other components that are compatible with this press system. Solder joints are acceptable where press system is not the appropriate application.

Joining Material:

Lead-Free Solder: ASTM B32; minimum tensile strength of 5,900 psi. Solder shall be certified to meet NSF 61 Annex G or NSF 372.

6-Inch and Larger: ASTM B88, Type L lead-free hard drawn copper tube.

Fittings:

Lead-Free Copper fittings with grooves designed to accept grooved end couplings. Standard fittings shall be copper per ASTM B75 alloy C12200 or ASTM B-152 C11000 and ASME/ANSI B 16.22; bronze sand castings per ASTM B584 copper alloy, UNS C89836 or C92200 per ASME/ANSI B16.18.
Lead-Free Cast Copper Alloy Flanges Class 150 and 300, Flat-Face Type: ASME B16.24.
Use dielectric waterways, gaskets, and flange kits when connecting dissimilar metals.

Flange Adapters:

Ductile Iron ASTM A-536, engaging directly into roll grooved copper tube and fittings and bolting directly to ANSI Class 125 cast iron and Class 150 steel flanged components.

Valves:

Valve types and sizes shall be installed as indicated in Section 220523, General-Duty Valves For Plumbing Piping and shall be compatible with the grooved system. Valves shall be by same manufacturer as the coupling manufacturer. Valves shall be compliant with NSF 61 Annex G or NSF 372.

Quality Assurance: All grooved joint couplings, fittings, valves and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.

Below Grade Inside Buildings:

Pipe 2-1/2 Inch and Smaller: ASTM B 88; Type K lead-free soft copper or Type K lead-free annealed copper tube.

Fittings:

Lead-Free Wrought Copper Solder-Joint Fittings: ANSI B16.22.
Lead-Free Cast Copper Solder-Joint Fittings: ASME B16.18.

Joining Material:

Brazing: ANSI/AWS A5.8.
Lead-free.
Brazing rods containing cadmium shall not be used.

Fluxes:

ANSI/AWS A5.31, Type FB3-A or FB3-C.

Pipe 3-Inch and Larger:

Ductile Iron Pipe: Class 52, ANSI A21.51; AWWA C151; 350 PSI pressure rating.

Cement Mortar Lining for Ductile Iron and Gray Iron Pipe and Fittings for Water: ANSI A21.4; AWWA C104.
Polyethylene Encasement for Gray and Ductile Cast Iron Piping: ANSI A21.5; AWWA C105.
Fittings:

Gray Iron Fittings: ANSI/AWWA C110/A21.10.
Ductile Iron Fittings: ANSI/AWWA C110/A21.10.

Joint Materials: Rubber gasket joints. ANSI/AWWA C111/A21.11.

PART 3 - EXECUTION

3.0 PIPING INSTALLATION

Install pipes and pipe fittings in accordance with recognized industry practices to achieve permanently leak proof piping systems, capable of performing service without piping failure. Install each run with minimum joints and couplings, but with adequate and accessible unions for disassembly and maintenance/ replacement of valves and equipment. Reduce sizes by use of reducing fittings. Align piping accurately at connections, within 1/16-inch misalignment tolerance.

Electrical Equipment Spaces: Do not run piping through transformer vaults and other electrical or electronic equipment spaces and enclosures. Only piping serving this type of equipment space shall be allowed.

Use fittings for all changes in direction and all branch connections.

Install piping straight, plumb, level and at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.

Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view.

Install piping tight to slabs, beams, joists, columns, walls, and other permanent elements of the building. Install piping free of sags or bends and allow sufficient space above removable ceiling panels to allow for panel removal.

Locate groups of pipes parallel to each other, spaced to permit application of insulation and servicing of valves.

Install means to drain the system at all low points in mains, risers, and branch lines.

Fire and Smoke Wall Penetrations: Maintain the fire and smoke rated integrity where pipes pass through fire and smoke rated walls, partitions, ceilings, and floors.

Exterior Wall Penetrations: Seal pipe penetrations through exterior walls using sleeves and mechanical sleeve seals. Use steel pipe for sleeves 6-inch and smaller. Use sheet metal for pipe sleeves 6-inch and larger.

Coordinate foundation and all other structural penetrations with Structural Engineer.

3.1 UNDERGROUND PIPE INSTALLATION

Clean fittings, nipples and other field joints thoroughly before coating.

Cast Iron Pipe:

Protect gray and ductile cast iron pipe installed below grade with polyethylene encasement applied in accordance with ANSI/AWWA C105/A21.5.
Install ductile iron pipe below grade as prescribed by AWWA C600.

Provide and install concrete thrust block and 3/4-inch steel threaded tie bar at each direction change on underground pressure pipe. Embed tie bar in thrust block and connect to upstream fitting. Paint tie bar with two (2) coats of Bitumastic #50 paint.

Bury all outside water piping minimum 6’-6” below grade to top of pipe.

3.2 SERVICE ENTRANCE

Extend water distribution piping 5'-0" outside of building.

Install sleeve and mechanical sleeve seal at penetrations through foundation wall for watertight installation.

Install shutoff valve at service entrance inside building; complete with strainer, pressure gauge, and test tee with valve.

3.3 EQUIPMENT CONNECTIONS

Piping Runouts to Fixtures: Provide hot and cold water piping run outs to fixtures of sizes indicated, but in no case smaller than required by Plumbing Code.

Mechanical Equipment Connections: Provide shutoff valve and union for each connection, provide drain valve on drain connection. For connections 2-1/2 inch and larger, use flanges instead of unions.

3.4 FIELD QUALITY CONTROL

Inspections: Inspect water distribution piping as follows:

Do not enclose, cover, or put into operation water distribution piping system until it has been inspected and approved by the Authority Having Jurisdiction.
During the progress of the installation, notify the Plumbing Official Having Jurisdiction, at least forty-eight (48) hours prior to the time such inspection must be made. Perform tests specified below in the presence of the Plumbing Official.

Rough-In Inspection: Arrange for inspection of the piping system before concealed or closed-in after system is roughed-in, and prior to setting fixtures.
Final Inspection: Arrange for a final inspection by the Plumbing Official to observe the tests specified below and to insure compliance with the requirements of the Plumbing Code.

Reinspections: Whenever the Plumbing Official finds that the piping system will not pass the test or inspection, make the required corrections and arrange for reinspection by the Plumbing Official.
Reports: Prepare inspection reports, signed by the Plumbing Official.

Piping Tests:

General: Provide temporary equipment for testing, including pump and gauges. Test piping system before insulation is installed wherever feasible. Test each natural section of each piping system independently but do not use piping system valves to isolate sections where test pressure exceeds valve pressure rating. Fill each section with water and pressurize for indicated pressure and time.
Test piping that is to be concealed before being permanently enclosed.
As soon as work has been completed, conduct preliminary tests to ascertain compliance with specified requirements. Make repairs or replacements as required.
Give a minimum of twenty-four (24) hours notice to Engineer of dates when acceptance test will be conducted. Conduct tests as specified for each system in presence of representative of Agency Having Jurisdiction or his representative. Submit three (3) copies of successful tests to the Engineer for his review. Report shall state system tested and date of successful test.

Obtain certificates of approval, acceptance and compliance with regulations of Agencies Having Jurisdiction. Work shall not be considered complete until such certificates have been delivered.

All costs involved in these tests shall be borne by Contractor.

System Tests:

Hydrostatic Test: Pressurize the system to 100psig or 150 percent of system pressure, whichever is greater. Maintain pressure until the entire system has been inspected for leaks, but in no case for a time period of less than four (4) hours.

Compressed Air or Nitrogen Test: Compressed air tests may be substituted for hydrostatic tests only when ambient conditions prohibit safe use of hydrostatic testing and must be reviewed by the Engineer prior to any testing. For tests of this type, subject the piping system to the gas pressure indicated for that specific system. Maintain the test pressure for the duration of a soapy water test of each joint. The air test is not allowed on CPVC piping systems.

Repair failed piping sections by disassembly and re-installation, using new materials to extent required to overcome leakage. Do not use chemicals, stop-leak compounds, mastics, or other temporary repair methods.

Drain test water from piping systems after testing and repair work has been completed.

3.5 ADJUSTING AND CLEANING

Clean and disinfect water distribution piping as follows:

Purge all new water distribution piping systems and parts of existing systems, which have been altered, extended, or repaired prior to use. Clean and replace strainers.

Use the purging and disinfecting procedure prescribed by the Authority Having Jurisdiction, or in case a method is not prescribed by that authority, the procedure described in either AWWA C651, or AWWA C652, or as described below:

Flush the piping system with clean, potable water until dirty water does not appear at the points of outlet.

Fill the system or part thereof, with a water/chlorine solution containing at least 50 parts per million of chlorine. Isolate (valve off) the system, or part thereof, and allow to stand for twenty-four (24) hours or fill with a water/chlorine solution containing at least 200 parts per million of chlorine and isolate and allow to stand for three (3) hours.

Following the allowed standing time, flush the system with clean potable water until chlorine does not remain in the water coming from the system.

Submit water samples in sterile bottles to the Authority Having Jurisdiction. Repeat the procedure if the biological examination made by the authority shows evidence of contamination.

Prepare reports for all purging and disinfecting activities.

END OF SECTION 22 11 16

SECTION 22 11 19

DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.0 DESCRIPTION OF WORK

This Section includes potable cold, hot, and recirculated hot water specialties within the building to a point 5-feet outside the building. This section includes the following:

Piping Specialties:

- Water Hammer Arrestors
- Strainers
- Hose Bibbs
- Wall and Yard Hydrants
- Hose Stations
- Backflow Preventers
- Thermostatic Mixing Valves
- Pressure/Temperature Relief Valves
- Vacuum Relief Valves

1.1 QUALITY ASSURANCE

Regulatory Requirements: Comply with the provisions of the following:

Local Plumbing Code and Utility Department requirements.
NSF 61 Compliance: Drinking Water System Components – Health Effects; Sections 1 through 9 and Annex G.
Safe Drinking Water Act – Public Law No. 111-380.
Montana Department of Environmental Quality
NSF/ANSI 372: Drinking Water System Components, Lead Content

All piping systems shall be installed to manufacturer's standards and in accordance with the pipe manufacturer's instructions. Contractor shall demonstrate prior to installation of any piping that joining methods and procedures are acceptable to the Engineer and/or Owner with the Factory Representative present. During the installation of the piping system, the Contractor shall be required to provide joint coupons as requested by the Owner or Engineer and repair and/or replace system if joints are deemed unsatisfactory.

1.2 INSTALLER'S QUALIFICATIONS

All Plumbing Work shall be performed by a State of Montana Licensed Contractor under the supervision of a Licensed Plumber. Contractors shall verify that plumbers are currently licensed by the State of Montana and shall supply the Project Manager with names and license numbers. Contractors shall have a minimum of three (3) years of satisfactory performance in conducting the type of work specified.

1.3 SUBMITTALS

Submit under provisions of Division 1.

1.4 CLOSEOUT SUBMITTALS

Submit under provisions of Division 1.

Test Reports.

Valve schedule listing valve designation number, valve type, size, location, and function of all valves.

Backflow Preventer State Certification Test.

PART 2 - PRODUCTS

2.0 PIPING SPECIALTIES

Water Hammer Arresters:

Piston type, with copper/brass casing and piston, pressure rated for 250 PSI, tested and certified in accordance with ASSE 1010 and NSF 372. Water hammer arrestor shall be designed to provide continuous protection, without maintenance, against excessive surge pressure. Size according to the following schedule.
Where water hammer arresters are installed, provide isolation valve on the branch to the arrester and an access panel.
Single or multiple fixture locations will not need an isolation valve and access panel if prior approval is first obtained by the authority having jurisdiction and owner.
Units shall be sized in accordance with the following table:

Drawing Designation	Fixture Unit Rating	P.D.I. Size	Connection Size
SA-1	1-11	A	1/2"
SA-2	12-32	B	3/4"
SA-3	33-60	C	1"
SA-4	61-113	D	1”
SA-5	114-154	E	1”
SA-6	155-330	F	1”

Acceptable Manufacturers:

Precision Plumbing Products
Sioux Chief
Jay R. Smith

Strainers:

Wye Pattern Strainers: ½-inch to 3-inch; 400 PSIG working pressure, lead-free brass or bronze construction, complete with bottom drain connection and removable Type 304 or 302, 20 mesh stainless steel screens. Strainer shall be certified to meet the-lead free requirements of NSF 61and NSF/ANSI 372.

Acceptable Manufacturers:

Wilkins
Watts

Wye Pattern Strainers: 3-inch to 8-inch; 200 PSIG working pressure, cast iron construction body coated with FDA approved epoxy for domestic water service, bottom drain connection, ANSI Class 125 flanged connections, 300 series perforated screens (1/16-inch perforations for 3 and 4 inch size, 1/8-in perforations for 6 and 8-inch size). Strainer shall be certified to meet the lead-free requirements of NSF 61 and NSF/ANSI 372.

Acceptable Manufacturers:

Wilkins
Watts
Febco

Hose Bibbs:

HB: Rough chrome plated bronze body, renewable composition disc, removable handle, 3/4-inch NPT inlet, vacuum breaker, 3/4-inch hose outlet.

Acceptable Manufacturers:

Chicago Faucet No. 998-RCF
Woodford
T&S Brass
Zurn

Wall and Yard Hydrants:

WH**:** Flush with wall, non-freeze, box type, wall hydrant; all brass with box cover and frame, "T" handle loose key, key lock cover, two (2) check valves, ASSE 1052 or 1019 approved, self draining body and shank, 3/4-inch male hose thread outlet, 3/4-inch male or female I.P.S. thread inlet, renewable seat; shank length to extend through primary exterior wall surface sufficient distance to prevent freezing.

Acceptable Manufacturers:

Woodford
Josam
Wade
Prier

Backflow Preventers:

BFP- (Reduced Pressure Type): All lead-free bronze (1/2-inch – 2-inch) body with two (2) independently operating, spring loaded check valves and one (1) differential relief valve with automatic intermediate atmospheric vent. Assembly to be furnished with full port, positive shutoff isolation valves, in-line strainer, union connections, funnel, and all test cocks. Assembly to have approval of National Sanitary Foundation, U.S.C. Foundation for Cross Connection Control, ASSE 1013, AWWA C511 compliant, IAPMO listed, State and or Local Authorities. Backflow preventer shall be certified to meet the lead-free requirements of NSF 61 and NSF/ANSI 372.

Acceptable Manufacturers:

Watts
Wilkins
Febco

BFP- (Reduced Pressure Type): Stainless Steel (2-1/2 inch – 6-inch) body with two (2) independently operating, spring loaded check valves and one (1) differential relief valve with automatic intermediate atmospheric vent. Assembly to be furnished with full port, positive shutoff isolation valves, in-line strainer, flanged connections, funnel, and all test cocks. Assembly to have approval of U.S.C. Foundation for Cross Connection Control, ASSE 1013, AWWA C511 compliant, UL classified (with OS&Y valves), FM approved, State and or Local Authorities. Backflow preventer shall be certified compliant to the lead-free requirements of NSF 372.

Acceptable Manufacturers:

Wilkins
Watts

BFP- (Carbonated Water for Beverage Dispensing Equipment, Coffee and Tea Brewers, Juicers): All lead-free stainless steel body and parts, double check valve with vent rated for 150 PSI at 130 degree F. Vent relief port shall be piped to a drain. Unit shall be ASSE 1022 listed and certified to meet the lead-free requirements of NSF 61 and NSF/ANSI 372.

Acceptable Manufacturers:

Wilkins
Watts

Thermostatic Mixing Valves:

TMV: Exposed type, all lead-free brass or bronze thermostatically controlled mixing valve with stainless steel piston, fail safe automatic shut-down if either hot or cold water pressure fails; union connection, integral check valves rough chrome finish. Valve shall be ASSE rated for the application. Valve shall be to meet the lead-free requirements of NSF 61 and NSF 372.

Acceptable Manufacturers:

Powers
Leonard
Symmons
Bradley

PART 3 - EXECUTION

3.0 INSTALLATION OF PIPING SPECIALTIES

Backflow Preventers:

Install in compliance with the International Plumbing Code and Authority Having Jurisdiction. Pipe relief outlet through air gap and without valves, to nearest floor drain.
Provide testing and report on all backflow prevention devices in accordance with the International Plumbing Code and the requirements. Attach testing approval tag to all back flow preventers.

Water Hammer Arresters:

Install water hammer arresters with isolation valve in accessible location.
Provide access doors located in accordance with architectural recommendations.

Water hammer arresters shall be installed at all quick-closing valve locations, at each set of flush valves and where hydrostatic shock pressures could occur.

Install mixing valves with integral check valves or in-line check valves, unions and isolation valves.

3.1 FIELD QUALITY CONTROL

Inspections: Inspect water distribution piping as follows:

Do not enclose, cover, or put into operation water distribution piping system until it has been inspected and approved by the Authority Having Jurisdiction.
During the progress of the installation, notify the Plumbing Official Having Jurisdiction, at least forty-eight (48) hours prior to the time such inspection must be made. Perform tests specified below in the presence of the Plumbing Official.

Rough-In Inspection: Arrange for inspection of the piping system before concealed or closed-in after system is roughed-in, and prior to setting fixtures.
Final Inspection: Arrange for a final inspection by the Plumbing Official to observe the tests specified below and to insure compliance with the requirements of the Plumbing Code.

Reinspections: Whenever the Plumbing Official finds that the piping system will not pass the test or inspection, make the required corrections and arrange for reinspection by the Plumbing Official.
Reports: Prepare inspection reports, signed by the Plumbing Official.

3.2 ADJUSTING AND CLEANING

Set field-adjustable pressure set points of water pressure-reducing valves.

Set field-adjustable flow set points of balancing valves.

Set field-adjustable temperature set points of temperature-actuated water mixing valves.

END OF SECTION 22 11 19

SECTION 22 11 23

DOMESTIC WATER PUMPS

PART 1 - GENERAL

1.0 DESCRIPTION OF WORK

Extent of Plumbing Pumps Work required by this section is indicated on drawings and schedules, and by requirements of this section.

Types of Pumps specified in this section include the following:

In-Line Recirculation Pumps

Pumps furnished as part of factory-fabricated equipment, are specified as part of equipment assembly in other Division 22 sections.

Refer to other Division 22 sections for insulation of pump housings; vibration control of plumbing pumps; not work of this section.

Refer to Division 26 sections for the following work; not work of this section.

Power supply wiring from power source to power connection on pumps. Include starters, disconnects, and required electrical devices, except where specified as furnished, or factory-installed, by manufacturer.
Interlock wiring between pumps; and between pumps and field-installed control devices.

Interlock wiring specified as factory-installed is work of this section.

Provide the following Electrical Work as work of this section, complying with requirements of Division 26 sections:

Control wiring between field-installed controls, indicating devices, and pump control panels.

1.1 QUALITY ASSURANCE

Manufacturer's Qualifications: Firms regularly engaged in manufacture of plumbing pumps with characteristics, sizes, and capacities required, whose products have been in satisfactory use in similar service for not less than five (5) years.

Codes and Standards:

HI Compliance: Design, manufacture, and install plumbing pumps in accordance with HI "Hydraulic Institute Standards".
UL Compliance: Design, manufacture, and install plumbing pumps in accordance with UL 778 "Motor Operated Water Pumps".
UL and NEMA Compliance: Provide electric motors and components which are listed and labeled by Underwriters Laboratories and comply with NEMA Standards.
NSF 61 Compliance: Drinking Water System Components – Health Effects; Sections 1 through 9 and Annex G.
Safe Drinking Water Act – Public Law No. 111-380.
NSF/ANSI 372: Drinking Water System Components, Lead Content

Certification, Pump Performance: Provide pumps whose performances, under specified operating conditions, are certified by manufacturer.

1.2 SUBMITTALS

Product Data: Submit manufacturer's pump specifications, installation and start-up instructions, and current accurate pump characteristic performance curves with selection points clearly indicated.

Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loadings, required clearances, and methods of assembly of components.

Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to plumbing pumps. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

Maintenance Data: Submit maintenance data and parts lists for each type of pump, control, and accessory; including "trouble-shooting" maintenance guide. Include this data, product data, shop drawings, and wiring diagrams in maintenance manual; in accordance with requirements of Division 1.

1.3 DELIVERY, STORAGE, AND HANDLING

Handle plumbing pumps and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged plumbing pumps or components; replace with new.

Store plumbing pumps and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.

Comply with Manufacturer's rigging and installation instructions for unloading plumbing pumps, and moving them to final location.

PART 2 - PRODUCTS

2.0 MANUFACTURERS

Manufacturer: Subject to compliance with requirements, provide products by one of the following:

In-Line Recirculation Pumps – Lead-Free:

Armstrong Pumps, Inc.
Bell & Gossett, A Xylem Brand
Grundfos Pumps Corp.
Taco, Inc.
Wilo

In-Line Recirculation Pumps – Lead-Free, ECM Technology (Electronically Commutated Motor):

Grundfos Pumps Corp.
Wilo

Aquastats:

Honeywell
Johnson Controls
Bell & Gossett, A Xylem Brand
Taco

2.1 PUMPS

General: Provide factory-tested pumps, thoroughly cleaned, and where applicable painted with one (1) coat of machinery enamel prior to shipment. Type, size, and capacity of each pump is listed in pump schedule. Provide pumps of same type by same manufacturer.

2.2 IN-LINE RECIRCULATION PUMPS

General: Provide in-line recirculation pumps where indicated, and of capacities as scheduled. Pumps shall be certified to the requirements of NSF/ANSI 372 and UL Listed.

Type: Horizontal, lubricated, designed for 125 psi working pressure, 225 degree F (107 degree C) continuous water temperature, and specifically designed for quiet operation.

Body: Lead-Free bronze or stainless steel construction.

Shaft: Stainless steel or non-metallic.

Bearings: Carbon bearings designed to be lubricated by the circulating fluid.

Seal: Mechanical.

Motor: Non-overloading at any point on pump curve, open, drip-proof, sleeve bearings, quiet operating, rubber mounted construction, built-in thermal overload protection or impedance protection.

Impeller: Non-metallic or non-ferrous.

2.3 IN-LINE RECIRCULATION PUMPS – ECM MOTOR

General: Provide in-line recirculation pumps where indicated, and of capacities as scheduled. Pumps shall be certified to the requirements of NSF/ANSI 372 and UL Listed.

Type: Horizontal, lubricated, designed for 145 psi working pressure, 230 degree F (110 degree C) continuous water temperature, and specifically designed for quiet operation.

Body: Lead-Free stainless steel construction.

Shaft: Stainless steel or non-metallic.

Bearings: Carbon bearings designed to be lubricated by the circulating fluid.

Seal: Mechanical.

Motor: Non-overloading at any point on pump curve, open, drip-proof, sleeve bearings, quiet operating, rubber mounted construction, built-in thermal overload protection or impedance protection.

Impeller: Non-metallic or non-ferrous.

Controls:

Pumps shall include electronic variable speed control to operate at constant/variable differential pressure control without external sensors. Automatic night setback control available as standard using self-taught technology.

Pumps to include integrated synchronous motors using ECM technology with permanent magnetic rotors, special sensor-less control electronics and single phase electronic converters.
Pumps to include IR (infra-red) interface for wireless communication with the optional infra-red monitor.
Integrated overload motor protection shall protect the pump against over/under voltage, over temperature of motor and/or electronics, over current, locked rotor and dry run (no load condition).
Fault contact “FC” terminals shall be included in the terminal box and are to be potentially free, normally closed contacts that open on the event of a failure.
Interface (IF) modules will be included where specified, installed in the terminal box. The modules will allow BMS communication via LONworks, BACnet, MODbus, and 0 – 10 volt DC control of speed or head setpoint, external minimum speed, external off, dual pump communication and pump operation status.

2.4 AQUASTATS

Pipe clip-on type, designed to thermostatically turn on and off B&G NBF or Taco “00” pump circulators. Pump on at 100 degrees F., pump off at 120 degrees F. Suitable for 1/2-inch or 3/4-inch pipe.

B&G Model No. AQS-1/2 (1/2-inch pipe) or AQS-3/4 (3/4-inch pipe)
Taco Model no. 563-2

Lead-free immersion type domestic water circulation controller with totally enclosed snap-acting switches to operate on temperature rise to setpoint, visible control point scale and external adjustment screw to permit easy setting, immersion well to be lead-free brass, copper or stainless steel and be certified compliant with NSF 61 Annex G and/or NSF/ANSI 372. Controller to be UL Listed.

Honeywell
Johnson Controls

PART 3 - EXECUTION

3.0 INSPECTION

Examine areas and conditions under which plumbing pumps are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.1 INSTALLATION OF PUMPS

General: Install plumbing pumps where indicated, in accordance with manufacturer's published installation instructions, complying with recognized industry practices to ensure that plumbing pumps comply with requirements and serve intended purposes.

Access: Provide access space around plumbing pumps for service as indicated, but in no case less than that recommended by manufacturer.

Support:

Install in-line pumps, supported from piping system.

Support: Refer to Division 22 section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for support and mounting requirements of plumbing pumps.

Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.

Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.

Piping Connections: Refer to Division 22 plumbing piping sections. Provide piping, valves, accessories, gauges, supports, and flexible connections as indicated.

ECM Technology pumps shall be installed with the motor shaft in a horizontal plane per manufacturers recommendations. The terminal box shall be located as per manufacturers recommendations.

3.2 ADJUSTING AND CLEANING

Alignment: Check alignment, and where necessary, realign shafts of motors and pumps within recommended tolerances by manufacturer, and in presence of manufacturer’s service representative.

Start-Up: Start-up in accordance with manufacturer's instructions.

Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION 22 11 23

SECTION 22 13 16

SANITARY WASTE & VENT PIPING

PART 1 - GENERAL

1.0 DESCRIPTION OF WORK

This Section specifies the following:

Pipe and Tube Materials:

Sanitary Drainage, Vents
Sump Pump Discharge
Equipment Drains and Overflows

1.1 DEFINITIONS

Building Drain: That part of the lowest piping of a drainage system which receives the discharge from soil, waste, and other drainage pipes inside the walls of the building and conveys it to the building sewer to a point 5'-0" outside the building wall.

Building Sewer: That part of the horizontal piping of a drainage system which extends from the end of the building drain and conveys its discharge to a public sewer, private sewer, individual sewage disposal system, or other point of disposal.

Drainage System: Includes all the piping within a public or private premises which conveys sewage, rain water or other liquid wastes to a point of disposal. It does not include the mains of public sewer systems or a private or public sewage treatment or disposal plant.

Vent System: Pipe or pipes installed to provide a flow of air to or from a drainage system, or to provide a circulation of air within such system to protect trap seals from siphonage and back pressure.

1.2 SUBMITTALS

Submit under provisions of Division 1.

1.3 CLOSEOUT SUBMITTALS

Submit under provisions of Division 1.

1.4 QUALITY ASSURANCE

Regulatory Requirements: Comply with the provisions of the following:

Plumbing Code Compliance: Comply with applicable portions of the International and Local Plumbing Code.
ANSI Compliance: Comply with applicable ANSI standards pertaining to materials, products, and installation of soil and waste systems.
ASSE Compliance: Comply with applicable ASSE standards pertaining to materials, products, and installation of soil and waste systems.
ASTM Compliance: Comply with applicable ASTM Standards pertaining to materials, products, and installation of soil and waste systems.
CISPI Compliance: Comply with applicable CISPI Standards pertaining to materials, products, and installation of soil and waste systems.
PDI Compliance: Comply with applicable PDI standards pertaining to products and installation of soil and waste systems.

PVC, PP and ABS Pipe: Only Contractor's personnel which have received training in the installation of this material and meet the manufacturer's qualifications shall do the assembly of such material.

PART 2 - PRODUCTS

2.0 SANITARY DRAINAGE AND VENTS

Above Grade:

Pipe 1-1/2 Inch to 10-Inch: Service class hubless cast iron soil pipe: CISPI 301, ASTM A888. Pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute and be listed by NSF International.

Fittings: CISPI 301, NSF International, hubless cast iron, long sweep bends.
Joining Material: Wide Body Couplings

For ASTM A888 pipe, ASTM C1540 assembly of Type 304 stainless steel clamp and shield with a minimum thickness of 0.015-inch or greater, ASTM C564 elastomeric sealing sleeve. Sealing bands shall require 80-inch pounds of torque per band.
Wide body couplings as follows:

Pipe 1-1/2 Inch to 4-Inch: 3-Inch sleeve with four (4) clamps.
Pipe 5 & 6: 4-Inch sleeve with six (6) clamps.
Pipe 8-Inch to 10-Inch: 4-Inch sleeve with six (6) clamps.

Couplings shall be manufactured in USA.
Acceptable Manufacturers – Wide Body Couplings:

Husky 4000 Series
Fernco Inc.
Ideal-Triden

Pipe 1-1/4 Inch to 4-Inch: DWV Copper Tube: ASTM B 306.

Fittings:

Cast Copper Solder-Joint Drainage Fittings: ASME B16.23.
Wrought Copper Solder-Joint Drainage Fittings: ASME B16.29.

Joining Material:

Solder: Lead-free ASTM B32, Solder shall be certified to meet NSF 61 Annex G and/or NSF 372.

Fluxes:

Lead-free ASTM B813 liquid or paste type.

Manufacturers (Cast Iron Pipe):

Tyler Pipe
AB&I
Charlotte Pipe & Foundry

Below Grade:

Pipe 2-Inch to 15-Inch: Service class cast iron hub-and-spigot soil pipe, ASTM A74. Pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute and be listed by NSF International.

Fittings: ASTM A74 cast iron service class, hub and spigot compression joint, long sweep bends.
Neoprene Compression Gaskets: ASTM C564.

Pipe 2-Inch to 16-Inch: Iron Pipe Size (IPS) Polyvinyl Chloride (PVC) Solid Wall Schedule 40 DWV.

Manufactured from virgin Type 1, Grade 1 PVC 1120 (Cell Class 12454-B) per ASTM D-1784.
Meet the dimensional, physical properties, and tolerances of ASTM D-1785 and ASTM D-2665.
Mark pipe with ASTM D-2665, nominal pipe size, and the symbols PVC and DWV at 5-foot intervals.
Fittings: ASTM D2665, PVC, solvent cement with long sweep bends. Injection molded conforming to National Sanitation Standard 14.
Joining Material:

Solvent cement suitable for type and size of pipe installed as recommended by the pipe manufacturer.
Make solvent cement joints from a two-step process with ASTM F656 primer manufactured for thermoplastic piping systems and solvent cement conforming to ASTM D-2564.

Manufacturers (Cast Iron Pipe):

Tyler Pipe
AB&I
Charlotte Pipe & Foundry

2.1 SUMP PUMP DISCHARGE

Above Grade - Inside Buildings:

Pipe 4-Inch and Smaller: ASTM B 88; Type L hard drawn copper tube.

Fittings:

Wrought Copper Solder-Joint Fittings: ASME B16.22.
Cast Copper Solder-Joint Fittings: ASME B16.18
Cast Copper Alloy Flanges, Class 150 and 300, Flat-Face Type: ASME B16.24

Joining Material:

Solder: Lead-free, ASTM B32, Solder shall be certified to meet NSF 61 Annex G and/or NSF 372.

Fluxes:

Lead-free, ASTM B813.

Below Grade - Inside Buildings:

Pipe 2-1/2 Inch and Smaller: ASTM B 88; Type K soft copper or Type K annealed copper tube.

Fittings:

Wrought Copper Solder-Joint Fittings: ANSI B16.22.
Cast Copper Solder-Joint Fittings: ASME B16.18

Joining Material:

Brazing: ANSI/AWS 5.8
Lead-free.
Brazing rods containing cadmium shall not be used.

Fluxes:

ANSI/AWS A5.31, Lead-free.

Gate Valve:

2-1/2 Inch and Smaller: MSS-SP-80, Class 150 rising stem, union bonnet, solid wedge, bonnet and wedge are to be of bronze ASTM B-62. Stems shall be silicon bronze ASTM B-371 or low-zinc alloy B-99, non-asbestos packing and malleable ductile iron hand wheel. Soldered end connections.

Acceptable Manufacturers:

Nibco
Milwaukee
Hammond

3-Inch and Larger: MSS-SP70, Class 125 OS&Y, bolted bonnet, ASTM A126 Class B cast iron body and bonnet, bronze trimmed, non-asbestos packing and gaskets, and cast iron hand wheel. Flanged end connections.

Acceptable Manufacturers:

Nibco
Milwaukee
Hammond

Swing Check Valve:

2-1/2 Inch and Smaller: MSS SP-80; Class 150 SWP, ASTM B-62 bronze body and bonnet, horizontal swing design, Y-pattern, with bronze seat disk. Threaded or soldered end connections.

Acceptable Manufacturers:

Nibco
Milwaukee
Hammond

3-Inch and Larger: MSS SP-71; Class 125, ASTM A126 Class B cast iron body with bronze trim, non-asbestos gasket, horizontal swing, and flanged ends.

Acceptable Manufacturers:

Nibco
Milwaukee
Hammond

2.2 EQUIPMENT DRAINS AND OVERFLOWS

Copper Pipe and Fittings:

DWV Copper Tube: ASTM B 306.
Fittings:

Cast Copper Solder-Joint Drainage Fittings: ASME B16.23.
Wrought Copper Solder-Joint Drainage Fittings: ASME B16.29.

Joining Material:

Solder: Lead-free, ASTM B32, Solder shall be certified to meet NSF 61 Annex G and/or NSF 372.

Fluxes:

Lead-free, ASTM B813.

PART 3 - EXECUTION

3.0 EXAMINATION

General: Install piping in accordance with Authorities Having Jurisdiction, except where more stringent requirements are indicated.

Inspect piping before installation to detect apparent defects. Mark defective materials with white paint and promptly remove from site.

Verify all dimensions by field measurements. Verify that all drainage and vent piping and specialties may be installed in accordance with pertinent codes and regulations, the original design, and the referenced standards.

Verify all existing grades, inverts, utilities, obstacles, and topographical conditions prior to installations.

Examine rough-in requirements for plumbing fixtures and other equipment having drain connections to verify actual locations of piping connections prior to installation.

Examine walls, floors, roof, and plumbing chases for suitable conditions where piping and specialties are to be installed.

Do not proceed until unsatisfactory conditions have been corrected.

3.1 PIPING INSTALLATION

Install plumbing drainage piping with 1/4-inch per foot (2 percent) downward slope in direction of drain for piping 3-inch and smaller, and 1/8-inch per foot (1 percent) for piping 4-inch and larger.

Install 1-inch thick extruded polystyrene over underground drainage piping above frost line and not under building. Provide width to extend minimum of 12-inch beyond each side of pipe. Install directly over pipe, centered on pipe centerline.

Provide thrust restraints consisting of bracing to structure and rodded joints at branches and changes in direction for cast iron pipe 5-inches and larger suspended within the building and for all changes in diameter greater than two pipe sizes.

Provide sway bracing to prevent shear at joints on cast iron piping suspended in excess of 18-inches on single rod hangers.

Provide rigid support sway bracing at all changes in direction greater than 45 degrees for all suspended cast iron piping for pipe sizes 4-inch and larger.

Install underground cast iron drain piping to conform with the plumbing code, and in accordance with the Cast Iron Soil Pipe Institute Engineering Manual. PVC piping shall be installed in accordance with ASTM D 2321 and the plumbing code.

Lay piping beginning at low point of system, true to grades and alignment indicated, with unbroken continuity of invert.

Place bell ends or groove ends of piping facing upstream.

Install gaskets in accordance with manufacturer's recommendations for use of lubricants, cements, and other special installation requirements.

Grade trench bottoms to provide a smooth, firm, and stable foundation, free from rock, throughout the length of the pipe.

Remove unstable, soft, and unsuitable materials at the surface upon which pipes shall be laid, and backfill with clean sand or pea gravel to indicated invert elevation.

Shape bottom of trench to fit the bottom 1/4 of the circumference of pipe. Fill unevenness with tamped sand. At each pipe joint dig bell holes to relieve the bell of the pipe of all loads, and to ensure continuous bearing of the pipe barrel on the foundation.

Minimum size of waste and vent piping installed under floor slab on grade shall be 2-inches.

Vent termination shall be a minimum **12** - inches above finished roof.

3.2 SERVICE CONNECTIONS

Before commencing work, check invert elevations required for sewer connections, confirm inverts and ensure that these can be properly connected with slope for drainage and cover to avoid freezing.

3.3 CONNECTIONS

Piping Runouts to Fixtures: Provide drainage and vent piping runouts to plumbing fixtures and drains, with approved trap, of sizes indicated; but in no case smaller than required by the Plumbing Code.

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

3.4 FIELD QUALITY CONTROL

Inspections:

Do not enclose, cover, or put into operation drainage and vent piping system until it has been inspected and approved by the Authority Having Jurisdiction.
During the progress of the installation, notify the Plumbing Official Having Jurisdiction, at least forty-eight (48) hours prior to the time such inspection must be made. Perform tests specified below in the presence of the Plumbing Official.

Rough-In Inspection: Arrange for inspection of the piping system before concealed or closed-in after system is roughed-in, and prior to setting fixtures.
Final Inspection: Arrange for a final inspection to observe the tests specified and to insure compliance with the requirements of the Plumbing Code.

Re-Inspections: Whenever the piping system fails to pass the test or inspection, make the required corrections, and arrange for re-inspection.
Reports: Prepare inspection reports, signed by the Plumbing Official.

Piping System Test: Test drainage and vent system in accordance with the procedures of the Authority Having Jurisdiction, or in the absence of a published procedure, as follows.

Subject all waste and vent piping, including building drain, and building sewer to a water test.
Tightly close all openings in the piping system except the highest opening, and fill the system with water to the point of overflow.
Maintain water in the system, or in the portion under test, for at least fifteen (15) minutes before inspection starts; the system shall then be tight to all points. No section shall be tested with less than a 10-foot head of water.

3.5 ADJUSTING AND CLEANING

Clean interior of piping. Remove dirt and debris as work progresses.

Clean drain strainers, domes, and traps. Remove dirt and debris.

3.6 PROTECTION

Protect drains during remainder of construction period, to avoid clogging with dirt and debris, and to prevent damage from traffic and construction work.

Place plugs in ends of uncompleted piping at end of day or whenever work stops. Piping shall not be left open ended during construction.

END OF SECTION 22 13 16

SECTION 22 13 19

SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.0 DESCRIPTION OF WORK

This Section specifies the following:

Drainage Piping Specialties:
- Trap Seal
- Cleanouts
- Floor Drains
- Floor Sinks
- Trench Drains

1.1 DEFINITIONS

Building Drain: That part of the lowest piping of a drainage system which receives the discharge from soil, waste, and other drainage pipes inside the walls of the building and conveys it to the building sewer to a point 5'-0" outside the building wall.

Building Sewer: That part of the horizontal piping of a drainage system which extends from the end of the building drain and conveys its discharge to a public sewer, private sewer, individual sewage disposal system, or other point of disposal.

Drainage System: Includes all the piping within a public or private premises which conveys sewage, rain water or other liquid wastes to a point of disposal. It does not include the mains of public sewer systems or a private or public sewage treatment or disposal plant.

Vent System: Pipe or pipes installed to provide a flow of air to or from a drainage system, or to provide a circulation of air within such system to protect trap seals from siphonage and back pressure.

1.2 SUBMITTALS

Submit under provisions of Division 1.

1.3 CLOSEOUT SUBMITTALS

Submit under provisions of Division 1.

1.4 QUALITY ASSURANCE

Regulatory Requirements: Comply with the provisions of the following:

Plumbing Code Compliance: Comply with applicable portions of the Uniform and Local Plumbing Code.

ANSI Compliance: Comply with applicable ANSI standards pertaining to materials, products, and installation of soil and waste systems.

ASSE Compliance: Comply with applicable ASSE standards pertaining to materials, products, and installation of soil and waste systems.

ASTM Compliance: Comply with applicable ASTM Standards pertaining to materials, products, and installation of soil and waste systems.

CISPI Compliance: Comply with applicable CISPI Standards pertaining to materials, products, and installation of soil and waste systems.

PDI Compliance: Comply with applicable PDI standards pertaining to products and installation of soil and waste systems.
PVC, PP and ABS Pipe: Only Contractor's personnel which have received training in the installation of this material and meet the manufacturer's qualifications shall do the assembly of such material.

PART 2 - PRODUCTS

2.0 DRAINAGE PIPING SPECIALTIES

Acceptable Manufacturers:

Josam Mfg. Co.
Smith (Jay R.) Mfg. Co.
Tyler Pipe; Subs. of Tyler Corp.
Zurn Industries Inc; Hydromechanics Division
Wade
Woodford
Precision Plumbing Products
Watts

Trap Seal:

Trap Seal Units:

Trap seal unit fits 2 to 6-inch floors drains. Installation shall not require special tools or silicon sealant. Listed to the requirements of ASSE 1072.

Cleanouts:

Cleanout Plugs: ASTM A74, Cast brass, threads complying with ANSI B2.1, and Local Plumbing Code.
Floor Cleanout: Round, cast iron body with recessed bronze closure plug; scoriated polished bronze frame and cover plate.
Wall Cleanout: Cleanout tee with raised head brass plug tapped for 1/4-20 thread; flat style chrome plated wall cover plate with holes for 1/4-inch bolt; 1/4-20 threaded bolt with chrome plated flat head.
Grade Cleanout or Interior Locations Subject to Vehicle Traffic: Round cast iron flanged housing with heavy duty ductile iron cover. Set in 36-inch square concrete pad. Available in pipe sizes 2-inch to 6-inch. Josam No. 58680-5.
Line Cleanout: Cast iron tapped cleanout ferrule with raised head brass plug.
Access Panels: Fire rated assembly compatible with wall rating.

Floor Drains:
Refer To Plumbing Fixture Schedule On Drawings

Floor Sinks:

Refer To Plumbing Fixture Schedule On Drawings

2.1 TRENCH DRAINS

Acceptable Manufacturers:

Cast Iron Trench Drains:

Mea-Josam Company

Non-Metallic Trench Drains:

Smith/ACO Drain Inc.
Zurn
ABT, Inc.
Mea-Josam Company
Dura-Trench

Cast Iron Trench Drains: Cast iron shallow hub body and grate with end plates and gaskets, integral anchor flange, assembled in standard lengths for total length and width as indicated, with the following features:

Sediment Bucket;
Flashing Device;
Heel-Proof Grate;
Vandal-Proof Grate;
Backwater Valve;
Dome Bottom Strainer;
Bottom Outlet, Inside Caulk.

Non-Metallic Trench Drains: Sheet Molding Compound-Glass Reinforced Polyester (SMC-GRP), Polypropylene, Polyethylene or Polyester resin and quartz aggregate, pre-cast, interlocking design, with bottom radius and minimum 0.5 percent slope.

Pre-Cast Material: Load rating Extra Heavy Duty for commercial solid tire traffic patterns, forklifts and impacts from steel struts or metal wheels, 135,000 lbs – 2788 psi

Mea-Josam Company Series Pro-Plus (SMC-GRP) 100 (4-inch wide)

Grates: Cast iron or steel as indicated, for heavy-duty truck traffic, with openings designed to prevent entry of bicycle or wheelchair tires.

PART 3 - EXECUTION

3.0 EXAMINATION

General: Install piping in accordance with Authorities Having Jurisdiction, except where more stringent requirements are indicated.

Inspect piping before installation to detect apparent defects. Mark defective materials with white paint and promptly remove from site.

Verify all dimensions by field measurements. Verify that all drainage and vent piping and specialties may be installed in accordance with pertinent codes and regulations, the original design, and the referenced standards.

Verify all existing grades, inverts, utilities, obstacles, and topographical conditions prior to installations.

Examine rough-in requirements for plumbing fixtures and other equipment having drain connections to verify actual locations of piping connections prior to installation.

Examine walls, floors, roof, and plumbing chases for suitable conditions where piping and specialties are to be installed.

Do not proceed until unsatisfactory conditions have been corrected.

3.1 INSTALLATION OF PIPING SPECIALTIES

Provide flashing for all floor drains, floor cleanouts and shower drains above grade. Make watertight with Chloraloy 240 underslab moisture vapor barrier as manufactured by the Nobel Co. of Grand Haven, Michigan. Extend flashing at least 24-inch from drain rim into floor membrane or on structural floor. Fasten flashing to drain clamp device and make watertight, durable joint. Provide flashing collar extension with all drains and cleanouts installed above grade.

Cleanouts: Lubricate plugs with mixture of graphite and linseed oil. Prior to building turnover remove cleanout plugs, re-lubricate and reinstall using only enough force to ensure permanent leakproof joint.

Above Ground Cleanouts: Install in above ground piping and building drain piping as indicated, and:

As required by Plumbing Code;
At each change in direction of piping greater than 45 degrees below slab;
At minimum intervals of 50-feet;
At base of each vertical soil or waste stack;
At sinks and urinals on grade;
At each upper terminal;
At egress of building (surface cleanout).
At each water closet or toilet group.

Cleanout Covers: Install floor and wall cleanout covers for concealed piping, types as indicated, and in accessible locations.

Access Panels: Where cleanouts are located at a fire rated wall, provide and install fire-rated access panels to maintain wall rating. Provide panel sized to allow access to the cleanout.

Floor Drains:

Install floor drains at low points of surface areas to be drained, or as indicated. Set tops of drains flush with finished floor.

Trap all drains connected to the sanitary sewer with minimum trap size that of drain connected.

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

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

Provide with P-trap the same size as the floor drain unless otherwise noted on Mechanical Drawings.

Provide flashing membrane for all floor drains in structure above slab on grade level.

Floor Sinks:

Trap all drains connected to the sanitary sewer with minimum trap size that of drain connected.

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

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

Provide with P-trap the same size as the floor drain unless otherwise noted on Mechanical Drawings.

Provide flashing membrane for all floor drains in structure above slab on grade level.

3.2 SERVICE CONNECTIONS

Before commencing work, check invert elevations required for sewer connections, confirm inverts and ensure that these can be properly connected with slope for drainage and cover to avoid freezing.

3.3 FIELD QUALITY CONTROL

Inspections:

Do not enclose, cover, or put into operation drainage and vent piping system until it has been inspected and approved by the Authority Having Jurisdiction.
During the progress of the installation, notify the Plumbing Official Having Jurisdiction, at least forty-eight (48) hours prior to the time such inspection must be made. Perform tests specified below in the presence of the Plumbing Official.

Rough-In Inspection: Arrange for inspection of the piping system before concealed or closed-in after system is roughed-in, and prior to setting fixtures.
Final Inspection: Arrange for a final inspection to observe the tests specified and to ensure compliance with the requirements of the Plumbing Code.

Re-Inspections: Whenever the piping system fails to pass the test or inspection, make the required corrections, and arrange for re-inspection.
Reports: Prepare inspection reports, signed by the Plumbing Official.

Piping System Test: Test drainage and vent system in accordance with the procedures of the Authority Having Jurisdiction, or in the absence of a published procedure, as follows.

Subject all waste and vent piping, including building drain, roof drain and building sewer to a water test.
Tightly close all openings in the piping system except the highest opening, and fill the system with water to the point of overflow.
Maintain water in the system, or in the portion under test, for at least fifteen (15) minutes before inspection starts; the system shall then be tight to all points. No section shall be tested with less than a 10-foot head of water.

3.4 ADJUSTING AND CLEANING

Clean interior of piping. Remove dirt and debris as work progresses.

Clean drain strainers, domes, and traps. Remove dirt and debris.

Rod all new piping to ensure there are not blockages or debris in piping.

Protect drains during remainder of construction period, to avoid clogging with dirt and debris, and to prevent damage from traffic and construction work.

Place plugs in ends of uncompleted piping at end of day or whenever work stops. Piping shall not be left open ended during construction.

END OF SECTION 22 13 19

SECTION 22 13 23

SANITARY WASTE INTERCEPTORS

PART 1 - GENERAL

1.0 DESCRIPTION OF WORK

Extent of Interceptors Work is indicated on drawings and provisions of this section, including schedules and equipment lists associated with either drawings or this section.

Refer to other Division 22 sections for drainage piping which is required external to interceptors; not work of this section.

1.1 QUALITY ASSURANCE

Manufacturer's Qualifications: Firms regularly engaged in manufacturer of interceptors of types and capacities required, whose products have been in satisfactory use in similar service for not less than five (5) years.

Codes and Standards:

PDI Compliance: Test and rate grease interceptors in accordance with PDI Standard G101, "Testing and Rating Procedure for Grease Interceptors".

1.2 SUBMITTALS

Product Data: Submit manufacturer's technical product data, including rated capacities of selected models indicated, weights, furnished specialties and accessories, and installation and start-up instructions.

Shop Drawings: Submit manufacturer's assembly type shop drawings indicating dimensions, weights, required clearances, and methods of assembly of all components.

Record Drawings: At project closeout, submit record drawings of installed systems products; in accordance with requirements of Division 1.

Maintenance Data: Submit maintenance data and parts lists for each type of interceptor. Include "trouble-shooting" maintenance guides. Include this data, product data, and shop drawings in maintenance manual; in accordance with requirements of Division 1.

1.3 DELIVERY, STORAGE, AND HANDLING

Handle interceptors carefully to prevent damage, and/or breaking. Do not install damaged or broken interceptors; replace with new.

Store interceptors in clean dry place. Protect from weather, dirt, water, construction debris, and physical damage.

PART 2 - PRODUCTS

2.0 ACCEPTABLE MANUFACTURERS

Manufacturers: Subject to compliance with requirements, provide products by one of the following:

Interceptors:

Josam
Rockford Sanitary Systems
J.R. Smith
Wade
Zurn
Copeland
Billings Precast

2.1 OIL AND SAND INTERCEPTORS

General: Provide oil and sand interceptors of size and capacity as indicated.

Construction: Cast iron, coated with acid resisting rubber on outside and inside. Provide flow control fitting.

Variations: Provide the following variations:

Steel extension.
Anchor flange.
Flashing flange and flashing device.

PART 3 - EXECUTION

3.0 EXAMINATION

Examine areas and conditions under which interceptors are to be installed, and substrate which will support interceptors. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.1 INSTALLATION OF INTERCEPTORS

General: Install interceptors as indicated, in accordance with manufacturer's installation instructions, and in compliance with applicable codes.

Support: Anchor interceptors securely to substrate, locate so adequate clearance is provided to remove covers and sediment baskets. Set recessed units so top of cover is flush with finished floor.

Piping: Connect inlet and outlet piping to interceptors.

3.2 PROTECTION

Protect interceptors during remainder of construction period, to avoid clogging with construction materials and debris, and to prevent damage from construction debris and traffic.

END OF SECTION 22 13 23

SECTION 22 14 13
STORM DRAINAGE PIPING

PART 1 - GENERAL

1.0 DESCRIPTION OF WORK

This Section specifies the following:

Pipe and Tube Materials:

Roof Drainage
Sub Surface Drainage Pipe

Drainage Piping Specialties:
Cleanouts
Area Drains
Roof Drains
Trench Drains

1.1 DEFINITIONS

Drainage System: Includes all the piping within a public or private premises which conveys rain water to a point of disposal. It does not include the mains of public sewer systems or a private or public sewage treatment or disposal plant.

1.2 SUBMITTALS

Submit under provisions of Division 1.

1.3 CLOSEOUT SUBMITTALS

Submit under provisions of Division 1.

1.4 QUALITY ASSURANCE

Regulatory Requirements: Comply with the provisions of the following:

Plumbing Code Compliance: Comply with applicable portions of **Uniform and Local** Plumbing Code.
ANSI Compliance: Comply with applicable ANSI standards pertaining to materials, products, and installation of soil and waste systems.
ASSE Compliance: Comply with applicable ASSE standards pertaining to materials, products, and installation of soil and waste systems.
ASTM Compliance: Comply with applicable ASTM Standards pertaining to materials, products, and installation of soil and waste systems.
CISPI Compliance: Comply with applicable CISPI Standards pertaining to materials, products, and installation of soil and waste systems.
PDI Compliance: Comply with applicable PDI standards pertaining to products and installation of soil and waste systems.
PVC, PP and ABS Pipe: Only Contractor's personnel which have received training in the installation of this material and meet the manufacturer's qualifications shall do the assembly of such material.

PART 2 - PRODUCTS

2.0 ROOF DRAINAGE

Above Grade – 30 Feet of Head or Less:

Pipe 1-1/2 Inch to 10-Inch: Service class hubless cast iron soil pipe: CISPI 301, ASTM A888.

Fittings: CISPI 301, hubless cast iron, long sweep bends.

Joining Material: Wide Body Couplings

For ASTM A888 pipe, ASTM C1540 assembly of Type 304 stainless steel clamp and shield with a minimum thickness of 0.015-inch or greater, ASTM C564 elastomeric sealing sleeve. Sealing bands shall require 80-inch pounds of torque per band.
Wide body couplings as follows:

Pipe 1-1/2 Inch to 4-Inch: 3-Inch sleeve with four (4) clamps.
Pipe 5 & 6 Inch: 4-Inch sleeve with six (6) clamps.
Pipe 8-Inch to 10-Inch: 4-Inch sleeve with six (6) clamps.
Coupling shall be manufactured in USA.

Manufacturers (Cast Iron Pipe):

Tyler Pipe
AB&I
Charlotte Pipe & Foundry

Above Grade – 30 Feet of Head or Greater:

Pipe 3-Inch to 10-Inch: Schedule 40 galvanized steel pipe with galvanized cast iron drainage fittings and threaded joints; or Schedule 40 grooved galvanized steel pipe joined with rigid couplings and gaskets designed for water service, molded of materials conforming to ASTM D-2000. Full lengths of pipe shall be utilized to greatest extent possible. Prior to transitioning to Hub and Spigot Piping at floor level, install a tee fitting for cleanout purposes. Material to be galvanized steel tee and removable cap rated for pressure piping, rated at 250 PSI minimum. Pipe and fittings shall be of domestic manufacture, or receive prior approval of the Engineer.

Below Grade:

Pipe 2-Inch to 15-Inch: Service class cast iron hub-and-spigot soil pipe, ASTM A74.

Fittings: ASTM A74 service class cast iron, hub and spigot compression joint, long sweep bends.
Neoprene Compression Gaskets: ASTM C564.

Manufacturers (Cast Iron Pipe):

Tyler Pipe
AB&I
Charlotte Pipe & Foundry

Pipe 2-Inch to 16-Inch: Iron Pipe Size (IPS) Polyvinyl Chloride (PVC) Solid Wal Schedule 40 DWV.

Manufactured from virgin Type 1, Grade 1 PVC 1120 (Cell Class 12454-B) per ASTM D-1784.
Meet the dimensional, physical properties, and tolerances of ASTM D-1785 and ASTM D-2665.
Mark pipe with ASTM D-2665, nominal pipe size, and the symbols PVC and DWV at 5-foot intervals.
Fittings: ASTM D2665, PVC, solvent cement with long sweep bends. Injection molded conforming to National Sanitation Standard 14.
Joining Material:

Solvent cement suitable for type and size of pipe installed as recommended by the pipe manufacturer.
Make solvent cement joints from a two-step process with ASTM F656 primer manufactured for thermoplastic piping systems and solvent cement conforming to ASTM D-2564.

2.1 DRAINAGE PIPING SPECIALTIES

Acceptable Manufacturers:

Josam Mfg. Co.
Smith (Jay R.) Mfg. Co.
Tyler Pipe; Subs. of Tyler Corp.
Zurn Industries Inc; Hydromechanics Division
Wade
Woodford
Precision Plumbing Products
Watts

Cleanouts:

Cleanout Plugs: ASTM A74, Cast brass, threads complying with ANSI B2.1, and Local Plumbing Code.
Floor Cleanout: Round, cast iron body with recessed bronze closure plug; scoriated polished bronze frame and cover plate.
Wall Cleanout: Cleanout tee with raised head brass plug tapped for 1/4-20 thread; flat style chrome plated wall cover plate with holes for 1/4-inch bolt; 1/4-20 threaded bolt with chrome plated flat head or provide fire rated access panel/assembly compatible with the wall rating.
Grade Cleanout or Interior Locations Subject to Vehicle Traffic: Round cast iron flanged housing with heavy duty cast iron cover. Set in 36-inch square concrete pad. Available in pipe sizes 2-inch to 6-inch. Jay R Smith No. 4260 series**.**
Line Cleanout: Cast iron tapped cleanout ferrule with raised head brass plug.

Area Drains:

Refer To Plumbing Fixture Schedule On Drawings.

Roof Drains:

RD: Cast iron body with sump, removable cast iron vandal-proof dome strainer, cast iron flashing flange and cast iron ring with integral gravel stop, underdeck clamp, sump receiver for locations where roof drain is not cast in place, no-hub bottom outlet.

Jay R. Smith Fig. 1010

DSN- Down Spout Nozzle: Cast bronze body and flange.

Jay R. Smith Fig. 1770

2.2 TRENCH DRAINS

Acceptable Manufacturers:

Cast Iron Trench Drains:

Mea-Josam Company

Non-Metallic Trench Drains:

Smith/ACO Drain Inc.
Zurn
ABT, Inc.
Mea-Josam Company
Dura-Trench

Cast Iron Trench Drains: Cast iron shallow hub body and grate with end plates and gaskets, integral anchor flange, assembled in standard lengths for total length and width as indicated, with the following features:

Sediment Bucket;
Flashing Device;
Heel-Proof Grate;
Vandal-Proof Grate;
Convex Grate;
Dome Bottom Strainer;
Bottom Outlet, Inside Caulk.

Non-Metallic Trench Drains: Sheet Molding Compound-Glass Reinforced Polyester (SMC-GRP), Polypropylene, Polyethylene or Polyester resin and quartz aggregate, pre-cast, interlocking design, with bottom radius and minimum 0.5 percent slope.

Pre-Cast Material: Load rating Extra Heavy Duty for commercial solid tire traffic patterns, forklifts and impacts from steel struts or metal wheels, 135,000 lbs – 2788 psi.

Mea-Josam Company Series Pro-Plus (SMC-GRP) 100 (4-inch wide).

Grates: Cast iron or steel as indicated, for heavy-duty truck traffic, with openings designed to prevent entry of bicycle or wheelchair tires.

PART 3 - EXECUTION

3.0 EXAMINATION

General: Install piping in accordance with Authorities Having Jurisdiction, except where more stringent requirements are indicated.

Inspect piping before installation to detect apparent defects. Mark defective materials with white paint and promptly remove from site.

Verify all dimensions by field measurements. Verify that all drainage piping and specialties may be installed in accordance with pertinent codes and regulations, the original design, and the referenced standards.

Verify all existing grades, inverts, utilities, obstacles, and topographical conditions prior to installations.

Examine walls, floors, roof, and plumbing chases for suitable conditions where piping and specialties are to be installed.

Do not proceed until unsatisfactory conditions have been corrected.

3.1 PIPING INSTALLATION

Install plumbing drainage piping with 1/4-inch per foot (2 percent) downward slope in direction of drain for piping 3-inch and smaller, and 1/8-inch per foot (1 percent) for piping 4-inch and larger.

Install 1-inch thick extruded polystyrene over underground drainage piping above frost line and not under building. Provide width to extend minimum of 12-inch beyond each side of pipe. Install directly over pipe, centered on pipe centerline.

Provide thrust restraints consisting of bracing to structure and rodded joints at branches and changes in direction for cast iron pipe 5-inches and larger suspended within the building and for all changes in diameter greater than two pipe sizes.

Provide sway bracing to prevent shear at joints on cast iron piping suspended in excess of 18-inches on single rod hangers.

Provide rigid support sway bracing at all changes in direction greater than 45 degrees for all suspended cast iron piping for pipe sizes 4-inch and larger.

Suspended PVC piping shall be installed using the same requirements as cast iron piping for thrust and sway bracing as indicated in the articles above. Hanger spacing shall be as recommended by the manufacturer and code.

Install underground cast iron drain piping to conform with the plumbing code, and in accordance with the Cast Iron Soil Pipe Institute Engineering Manual PVC piping shall be installed in accordance with ASTM 2321 and the plumbing code.

Lay piping beginning at low point of system, true to grades and alignment indicated, with unbroken continuity of invert.

Place bell ends or groove ends of piping facing upstream.

Install gaskets in accordance with manufacturer's recommendations for use of lubricants, cements, and other special installation requirements.

Grade trench bottoms to provide a smooth, firm, and stable foundation, free from rock, throughout the length of the pipe.

Remove unstable, soft, and unsuitable materials at the surface upon which pipes shall be laid, and backfill with clean sand or pea gravel to indicated invert elevation.

Shape bottom of trench to fit the bottom 1/4 of the circumference of pipe. Fill unevenness with tamped sand. At each pipe joint dig bell holes to relieve the bell of the pipe of all loads, and to ensure continuous bearing of the pipe barrel on the foundation.

3.2 INSTALLATION OF PIPING SPECIALTIES

Cleanouts: Lubricate plugs with mixture of graphite and linseed oil. Prior to building turnover remove cleanout plugs, re-lubricate and reinstall using only enough force to ensure permanent leakproof joint.

Above Ground Cleanouts: Install in above ground piping and building drain piping as indicated, and:

As required by Plumbing Code;
At each change in direction of piping greater than 45 degrees below slab;
At minimum intervals of 50-feet;
At base of each vertical soil or waste stack;
At egress of building (surface cleanout).

Cleanout Covers: Install floor and wall cleanout covers for concealed piping, types as indicated, and in accessible locations.
Rated Access Panels: Where cleanouts are located at a fire rated wall, provide and install fire-rated access panels to maintain wall rating. Provide panel sized to allow access to the cleanout.

Roof Drains:

Install roof drains at low points of roof areas, in accordance with the roof membrane manufacturer's installation instructions.
Install drain flashing collar or flange so that no leakage occurs between roof drain and adjoining roofing. Maintain integrity of waterproof membranes, where penetrated.
Position roof drains so that they are accessible and easy to maintain.
Install overflow roof drains with the inlet flow line located a maximum 2-inch above the lowest point of roof.

3.3 SERVICE CONNECTIONS

Before commencing work, check invert elevations required for sewer connections, confirm inverts and ensure that these can be properly connected with slope for drainage and cover to avoid freezing.

3.4 FIELD QUALITY CONTROL

Inspections:

Do not enclose, cover, or put into operation drainage piping system until it has been inspected and approved by the Authority Having Jurisdiction.

During the progress of the installation, notify the Plumbing Official Having Jurisdiction, at least forty-eight (48) hours prior to the time such inspection must be made. Perform tests specified below in the presence of the Plumbing Official.

Rough-In Inspection: Arrange for inspection of the piping system before concealed or closed-in after system is roughed-in, and prior to setting fixtures.
Final Inspection: Arrange for a final inspection to observe the tests specified and to insure compliance with the requirements of the Plumbing Code.

Re-Inspections: Whenever the piping system fails to pass the test or inspection, make the required corrections, and arrange for re-inspection.
Reports: Prepare inspection reports, signed by the Plumbing Official.

Piping System Test: Test drainage and vent system in accordance with the procedures of the Authority Having Jurisdiction, or in the absence of a published procedure, as follows.

Subject all roof drain piping to a water test.
Tightly close all openings in the piping system except the highest opening, and fill the system with water to the point of overflow.
Maintain water in the system, or in the portion under test, for at least fifteen (15) minutes before inspection starts; the system shall then be tight to all points. No section shall be tested with less than a 10-foot head of water.
Close roof drains at the lowest point and fill with water to the point of overflow.

3.5 ADJUSTING AND CLEANING

Clean interior of piping. Remove dirt and debris as work progresses.

Clean drain strainers, domes, and traps. Remove dirt and debris.

3.6 PROTECTION

Protect drains during remainder of construction period, to avoid clogging with dirt and debris, and to prevent damage from traffic and construction work.

Place plugs in ends of uncompleted piping at end of day or whenever work stops. Piping shall not be left open ended during construction.

END OF SECTION 22 14 13

SECTION 22 14 29
SUMP PUMPS

PART 1 - GENERAL

1.0 DESCRIPTION OF WORK

Extent of Sump Pumps Work required by this section is indicated on drawings and schedules, and by requirements of this section.

Types of Pumps specified in this section include the following:

Submersible Elevator Sump Pumps

Pumps furnished as part of factory-fabricated equipment, are specified as part of equipment assembly in other Division 22 sections.

Refer to other Division 22 sections for insulation of pump housings; vibration control of plumbing pumps; not work of this section.

Refer to Division 26 sections for the following work; not work of this section.

Power supply wiring from power source to power connection on pumps. Include starters, disconnects, and required electrical devices, except where specified as furnished, or factory-installed, by manufacturer.
Interlock wiring between pumps; and between pumps and field-installed control devices.

Interlock wiring specified as factory-installed is work of this section.

Provide the following Electrical Work as work of this section, complying with requirements of Division 26 sections:

Control wiring between field-installed controls, indicating devices, and pump control panels.

1.1 QUALITY ASSURANCE

Manufacturer's Qualifications: Firms regularly engaged in manufacture of plumbing pumps with characteristics, sizes, and capacities required, whose products have been in satisfactory use in similar service for not less than five (5) years.

Codes and Standards:

HI Compliance: Design, manufacture, and install plumbing pumps in accordance with HI "Hydraulic Institute Standards".
UL Compliance: Design, manufacture, and install plumbing pumps in accordance with UL 778 "Motor Operated Water Pumps".
UL and NEMA Compliance: Provide electric motors and components which are listed and labeled by Underwriters Laboratories and comply with NEMA Standards.

Certification, Pump Performance: Provide pumps whose performances, under specified operating conditions, are certified by manufacturer.

1.2 SUBMITTALS

Product Data: Submit manufacturer's pump specifications, installation and start-up instructions, and current accurate pump characteristic performance curves with selection points clearly indicated.

Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loadings, required clearances, and methods of assembly of components.

Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to plumbing pumps. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

Maintenance Data: Submit maintenance data and parts lists for each type of pump, control, and accessory; including "trouble-shooting" maintenance guide. Include this data, product data, shop drawings, and wiring diagrams in maintenance manual; in accordance with requirements of Division 1.

1.3 DELIVERY, STORAGE, AND HANDLING

Handle plumbing pumps and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged plumbing pumps or components; replace with new.

Store plumbing pumps and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.

Comply with Manufacturer's rigging and installation instructions for unloading plumbing pumps, and moving them to final location.

PART 2 - PRODUCTS

2.0 MANUFACTURERS

Manufacturer: Subject to compliance with requirements, provide products by one of the following:

Submersible Elevator Sump Pumps:

Weil Pump Co.
Stancor Pumps
Bell & Gossett
Goulds
Liberty
Little Giant

2.1 PUMPS

General: Provide factory-tested pumps, thoroughly cleaned, and painted with one (1) coat of machinery enamel prior to shipment. Type, size, and capacity of each pump is listed in pump schedule. Provide pumps of same type by same manufacturer.

2.2 SUBMERSIBLE ELEVATOR SUMP PUMPS – WITH OIL DETECTION SYSTEM

General: Provide submersible sump pumps as indicated, of size and capacity as scheduled.

Pump: Cast iron shell, cast iron impeller, stainless steel shaft, factory-sealed grease lubricated ball bearings, ceramic mechanical seal, and perforated steel strainer. The impeller shall be a multi-vane, semi-open type. All exterior hardware shall be 304 stainless steel. Pump shall include a lifting handle to simplify locating and lifting of the pump.

Motor: NEMA 6, shall be air filled with Class F insulation. Single phase motors shall include built in automatic reset thermal and overload protection. The motor shaft shall be solid stainless steel. Both upper and lower bearings shall be single sealed and permanently lubricated. The motor cover shall include a cable sealing system to prevent water from entering the motor.

Mechanical Seal: Single mechanical seal, carbon against ceramic. All elastomers shall be Buna-N material.

Oil Detection System: Provide discriminating liquid sensor probe, wiring, control panel.

Controls:

Control Panel: Internal logic discriminates between water and hydrocarbon-based liquids with no moving parts. The solid state switching is encased in a rugged housing ensuring dependable service and durability.

UL Listed Label
NEMA 4X Non-Metallic Enclosure
TEST-OFF-AUTO switch for each pump
Panel to be constructed to accommodate the scheduled HP and voltage.
High Water Alarm (HWA) with 95dB horn and silence button
Discriminating Liquid Sensor
Pump Shut Down Circuit
Hydrocarbon indicator light
Hydrocarbon indicator alarm
25 feet of sensor cable
Isolated contact for Discriminating Liquid Sensor
Fused Control Transformer
Single Phase – Automatic reset thermal and overload protection
One set of dry contacts for monitoring: HWA
Provide 3 tethered float switches. Configure for Off/Stop, Start and High Water Alarm

PART 3 - EXECUTION

3.0 INSPECTION

Examine areas and conditions under which plumbing pumps are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.1 INSTALLATION OF PUMPS

General: Install plumbing pumps where indicated, in accordance with manufacturer's published installation instructions, complying with recognized industry practices to ensure that plumbing pumps comply with requirements and serve intended purposes.

Access: Provide access space around plumbing pumps for service as indicated, but in no case less than that recommended by manufacturer.

Support: Refer to Division 22 section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for support and mounting requirements of plumbing pumps.

Basins: Install sump pump basins in indicated locations and connect to sewer lines. Brace interior of basin in accordance with manufacturer's instructions, to prevent distortion or collapse during concrete placement. Refer to Division 3 for concrete work; not work of this section. Set cover over basin, fasten to top flange of basin. Install so cover is flush with finished floor.

Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.

Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.

Piping Connections: Refer to Division 22 plumbing piping sections. Provide piping, valves, accessories, gauges, supports, and flexible connections as indicated.

3.2 ADJUSTING AND CLEANING

Alignment: Check alignment, and where necessary, realign shafts of motors and pumps within recommended tolerances by manufacturer, and in presence of manufacturer’s service representative.

Start-Up: Start-up in accordance with manufacturer's instructions.

Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION 22 14 29

SECTION 22 31 00
WATER TREATMENT

PART 1 - GENERAL

1.0 DESCRIPTION OF WORK

Extent of Water Treatment System Work required by this section is indicated on drawings and schedules and by requirements of this section, and includes necessary equipment, chemicals, and service for the following systems:

Water Conditioners
Cleaning of Piping Systems
Sterilization of Domestic Water System

Provide chemicals and service program for a period of one (1) year from start-up date of equipment, including the following:

Initial water analysis and recommendations.
Systems start-up assistance.
Training of operating personnel.
Periodic field service and consultation.
Customer report charts and log sheets.
Laboratory technical assistance.

1.1 QUALITY ASSURANCE

Manufacturer's and Representative Qualifications. Firms regularly engaged in manufacture of water treatment equipment, chemical and service shall have been active in the field of industrial water treatment and whose products have been in satisfactory use in similar service for not less than five (5) years, and shall have full-time service personnel located within the trading area of job site.

Codes and Standards:

ASME Compliance: Construct softener tanks in accordance with ASME Boiler and Pressure Vessel Code, Section VIII, provide stamp and certification.
UL Labels: Provide water conditioners ancillary electrical components which have been listed and labeled by UL.
NEMA Standards: Provide electrical controls and enclosures conforming to applicable standards of NEMA for environment where water conditioners are indicated.
NSF Compliance: Construct and install water conditioners in accordance with NSF Standard 44 "Cation Exchange Water Softeners Relating to Supplementary Treatment of Potable Water".
Chemical Standards: Provide only chemical products which are acceptable under state and local public health and pollution control regulations.

1.2 SUBMITTALS

Product Data: Submit manufacturer's technical product including rated capacities of selected equipment clearly indicating water pressure drops, weights, installation and start-up instructions, and furnished specialties and accessories.

Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loadings, required clearances, and methods of assembly of components.

Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to water treatment equipment. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

Record Drawings: At project closeout, submit record drawings of installed systems products in accordance with requirements of Division 1.

Maintenance Data: Submit maintenance data and parts list for each item of equipment, control, and accessory; including "trouble-shooting" maintenance guide. Include this data, product data, shop drawings, and wiring diagrams in maintenance manual, in accordance with requirements of Division 1.

1.3 DELIVERY, STORAGE AND HANDLING

Handle water treatment materials and components carefully to prevent damage, breaking, denting and scoring to materials and equipment. Deliver packaged units in original crates. Do not install damaged water treatment materials and components; remove from site and replace with new.

Store water treatment materials and components in an environment satisfactory to prevent their damage by the elements.

1.4 EXTENDED MAINTENANCE SERVICES

Agreement to Maintain: Prior to time of final acceptance, submit four (4) copies of "Agreement for Continued Service and Maintenance" for water treatment system, for Owner's possible acceptance. Offer terms and conditions for furnishing chemicals and providing continued testing and servicing, and including replacement of materials and equipment, for one (1) year period with option for renewal of Agreement by Owner.

PART 2 - PRODUCTS

2.0 MANUFACTURERS

Manufacturer: Subject to compliance with requirements, provide products by one of the following:

Water Conditioners and Filtering Equipment:

Columbia Water Conditioning Co.
Permuitt
Culligan
Marlo

2.1 WATER CONDITIONERS

COMMERCIAL WATER SOFTENER (FIBERGLASS TANKS):

General: Provide twin vertical tanks as specified below, each with a **36**-inch by **72**-inch diameter mineral tank. The tanks shall be of the vertical down flow pressure type with automatic controls to operate on the sodium cycle. The system shall be capable of delivering soft water at **185** gpm continuously with a pressure drop not to exceed 15 psig. The influent and effluent piping and valves shall be **3**-inches in size. The mineral tanks shall be of one-piece construction throughout, with no seams, no welds, and no joints. The tank shall have an operating pressure of 150 psig at 120 degree F.

NSF Compliance: Construct and install water conditioners in accordance with NSF Standard 44 "Cation Exchange Water Softeners Relating to Supplementary Treatment of Potable Water".
Mineral Standards: Provide mineral products acceptable under state and local public health control regulations.
Freeboard: Provide minimum freeboard of 50 percent of the mineral bed depth to allow for adequate resin expansion during backwash.

Controls: The system controls shall have adjustable duration of the various steps in regeneration and shall allow for push button start, as well as complete manual override operations. Softener regeneration shall be initiated by:

One (1) of two (2) electronic register head water meters, that will produce an electrical signal to indicate need for regeneration upon reaching hand set gallonage. Design so signal will continue until reset. Meter shall be capable of indicating rate of flow and total flow.

Provide electrical lockouts on multiple units to prevent more than one (1) softener from regenerating at any one time.

One (1) single water meter in a common outlet header, that will automatically regenerate each softener at pre-set gallonage and divert water flow to the other unit. Meter shall be capable of indicating rate of flow and total flow.

Provide electrical lockouts on multiple units to prevent more than one (1) softener from regenerating at any one time.

Main Operating Valve: Provide a 5-cycle diaphragm control valve assembly, with no moving teflon internal "jam resistant" internal part.
Mineral Standards: Provide mineral products acceptable under state and local public health control regulations.

Brine System: Provide a single brine measuring and dry salt storage tank sized for at least four (4) regeneration at full salting. The brine tank shall be constructed from rigid polyethylene with a special built-in salt grid system and polyethylene cover. Equip brine tank with float-operated plastic fitted brine valve for automatic control of brine withdraw and fresh water refill.

PART 3 - EXECUTION

3.0 CHLORINATION

Acceptable products are:

Liquid Chlorine	Fed. Spec. BB-C120B
Hypochlorite	Fed. Spec 0-C-114, Type 11, Grade B
	Fed. Spec. 0-S-60D, Grade A or B

After all pressure tests have been performed and piping has been flushed clean, the Chemical Treatment Contractor shall be responsible for sterilizing the domestic water lines.

Chlorination procedures shall comply with local code and health department regulations.

The Plumbing Contractor shall inform the General Contractor that the water system is to be chlorinated forty-eight (48) hours in advance, so that arrangements can be made for other trades not to use the water.
Before commencing the chlorination process, the Water Treatment Contractor shall post signs at each water fountain, and on each restroom door, stating that the water is not fit for drinking, and that the water is being chlorinated.

Introduce sufficient chlorine into the domestic water system to provide a dosage of not less than 50 parts per million at each faucet and valve. The chlorine solution shall then be allowed to stand for a minimum of twenty-four (24) hours in the system.

At the end of 24 hours, test shall be made for residual chlorine at the extreme end of the system from the point where chlorine was introduced. If chlorine residual is less than 10 ppm, the chlorination procedure shall be repeated.

Flush the system with a clean supply of water until the chlorine residual in the system is reduced to less than 1 ppm, or to the chlorine residual of the supply water. During the flushing, each faucet and valve in the system shall be opened and closed a minimum of four (4) times.

After 24 hours, the water treatment representative will have samples taken and tested by an independent laboratory. The system must be free of bacteriological contamination. If the system is contaminated, it shall be re-chlorinated until a satisfactory test is made.

The Water Treatment Contractor shall write a letter, informing the Plumbing Contractor that the building has been successfully chlorinated, and that the water is fit for human consumption.

3.1 INSTALLATION

Coordination where installation of Water Treatment equipment in piping systems is required with the other work (plumbing and heating piping) as necessary to interface components of water treatment equipment. Provide installation instructions to those firms providing installation.

3.2 INSTALLATION OF WATER CONDITIONERS

General: Install water conditioners where indicated, in accordance with equipment manufacturer's written instructions, and with recognized industry practices, to ensure that water conditioners comply with requirements and service for the intended purposes.

Access: Provide access and service space around and over water conditioners as indicated, but in no case less than that recommended by manufacturer.

Support: Provide 4-inch high concrete pad under water conditioners. Plumb and level units.

Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.

Verify that electrical wiring installation in accordance with manufacturer's submittal and installation requirements of Division 26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to Equipment Installer.

Piping Connections: Provide shutoff valves and unions or flanges on water connections. Pipe drain to nearest floor drain of suitable size for the backwash of the softener.

3.3 INSPECTION

Examine areas and conditions under which water treatment systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.4 FIELD QUALITY CONTROL

Sample water softener effluent at one (1) week intervals after start-up for period of three (3) weeks and prepare test report on the conditions of the water.

3.5 SYSTEM START-UP

The Water Treatment Supplier shall put the system into operation, and make adjustments necessary for proper operation.

The Water Treatment Supplier shall provide a written report to the Division 22 Contractor indicating that the start-up has been completed and that all Water Treatment Equipment is operating properly.

3.6 TESTING AND CLEANING

Sample all treated water systems at one (1) week intervals after start-up for period of four (4) weeks and prepare certified test report for each system being treated.

Start-up test, and adjust water conditioners in presence of manufacturer's authorized representative. Operate units including regeneration, back washing, rinsing and flushing. Adjust unit to maintain required steady state effluent water quality.

Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

3.7 EXTRA STOCK

In addition to startup salt, furnish ten (10) 80-pound bags of salt on a pallet and store where requested by Owner. Obtain a receipt from Owner for this salt.

3.8 CLOSEOUT PROCEDURES

Provide services of manufacturer's technical representative for one (1) 8-hour day to instruct Owner's personnel in operation and maintenance of water treatment systems.

Schedule training with Owner, provide at least seven (7) day notice to Contractor and Engineer of training date.

END OF SECTION 22 31 00

SECTION 22 32 00
WATER HEATERS

PART 1 - GENERAL

1.0 DESCRIPTION OF WORK

Extent of Water Heater Work required by this section is indicated on drawings and schedules, and by requirements of this section.

Refer to other Division 23 sections for piping, specialties, pumps, gas piping; breechings which are required external to water heaters for installation; for field installed automatic temperature controls required in conjunction with water heaters; not work of this section.

Electrical Work: Refer to Division 22 section "Mechanical/Electrical Requirements for Mechanical Equipment" for requirements.

Electrical Work: Provide the following wiring as work of this section, in accordance with requirements of Division 26:

Low voltage wiring between water heaters and remote mounted thermostats and controls.
Provide factory-mounted and factory-wired controls and electrical devices as specified in this section.

Refer to Division 26 sections for other electrical wiring including motor starters, disconnects, wires/cables, raceways, and other required electrical devices; not work of this section.

1.1 QUALITY ASSURANCE

Manufacturer's Qualifications: Firms regularly engaged in manufacturer of water heaters of types and capacities required, whose products have been in satisfactory use in similar service for not less than five (5) years.

Codes and Standards:

UL Compliances: Construct water heaters in accordance with the following UL Standards:

UL 174, "Household Electric Storage-Tank Water Heaters".
UL 499, “Electric Heating Appliances”.
UL 1261, "Electric Water Heaters for Pools and Tubs".
UL 1453, "Electric Booster and Commercial Storage Tank Water Heaters".

Provide water heater components which are UL-listed and labeled.
NSF Compliance: Construct and install water heaters located in food service establishments in accordance with NSF 5, "Standard for Hot Water Generating Equipment for Food Service Establishments using Spray Type Dish Washing Machines".
NSF Compliance: Construct and install water heater in accordance with NSF 372.
NEC Compliance: Install electric water heaters in accordance with requirements of NFPA 70, "National Electrical Code".
NFPA Compliance: Install gas-fired water heaters in accordance with requirements of NFPA 54, "National Fuel Gas Code".
Uniform Plumbing Code Compliance: Install water heaters in accordance with requirements of the “Uniform Plumbing Code”.
International Fuel Gas Code Compliance: Install gas-fired water heaters in accordance with requirements of the “International Fuel Gas Code”.

CSA International Labels: Provide water heaters which are listed and labeled by CSA International.

ASME Code Symbol Stamps: Provide water heaters and safety relief valves which comply with ASME Boiler and Pressure Vessel Code, and are stamped with appropriate code symbols.

ASHRAE Compliance: Provide water heaters with Performance Efficiencies not less than prescribed in the latest edition of ASHRAE 90.1, "Energy Standards for Buildings except Low-Rise Residential Buildings".

1.2 SUBMITTALS

Product Data: Submit manufacturer's technical product data including rated capacities and efficiencies of selected model clearly indicated; operating weights; furnished specialties and accessories; and installation and start-up instructions.

Shop Drawings: Submit manufacturer's assembly type shop drawings indicating dimensions, required clearances, and methods of assembly of components.

Wiring Diagrams: Submit manufacturer's electrical requirements for electrical power supply wiring to water heaters. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring required for final installation of water heaters and controls. Differentiate between portions of wiring that are factory-installed and portions that are to be field-installed.

Record Drawings: At project closeout, submit record drawings of installed systems products; in accordance with requirements of Division 1.

Maintenance Data: Submit maintenance data and parts lists for each type and size of water heater, control, and accessory; including "trouble-shooting" maintenance guide. Include this data, product data, shop drawings, and wiring diagrams in maintenance manual; in accordance with requirements of Division 1.

Certificates: Submit appropriate Certificates of Shop Inspection and Data Report as required by provisions of ASME Boiler and Pressure Vessel Code.

1.3 DELIVERY, STORAGE, AND HANDLING

Handle water heaters and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged water heaters or components; remove from site and replace with new.

Store water heaters and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.

Comply with manufacturer's rigging and installation instructions for unloading water heaters, and moving units to final location for installation.

1.4 SPECIAL PROJECT WARRANTY

Warranty on Coil, Heat Exchanger, and Burner: Provide written warranty, signed by manufacturer, agreeing to replace/repair, within warranty period, coils, heat exchangers, and burners with inadequate or defective materials and workmanship, including leakage, breakage, improper assembly, or failure to perform as required; provided manufacturer's instructions for handling, installing, protecting, and maintaining units have been adhered to during warranty period. Replacement is limited to component replacement only, and does not include labor for removal and reinstallation.

PART 2 - PRODUCTS

2.0 MANUFACTURERS

Manufacturers: Subject to compliance with requirements, provide products by one of the following:

Commercial Gas-Fired – High Efficiency, Sealed Combustion

A.O. Smith
Rheem
PVI Industries
State
Lochinvar
Bock
Bradford-White

Commercial Electric – Light Duty:

Rheem Water Heater Division; City Investing Co.
Smith Corp (A.O.); Consumer Products Division
State Industries, Inc.
PVI Industries
Lochinvar
Bradford-White

Expansion Tanks

Amtrol – Therm-X-Trol
Watts
State Industries, Inc.
Taco, Inc.
American Wheatley
Armstrong

Provide ASME stamped heaters when storage capacity exceeds 119 gallons and/or the input exceeds 199,000 BTUH. When the water heater is required to be stamped the corresponding expansion tank shall bear the ASME stamp as well. Electric water heaters with an input of 58 KW or greater require the ASME stamp.

Bottom fed cold water supply storage tanks require a vacuum relief valve conforming to ANSI Z21.22 be installed on the supply piping.

2.1 COMMERCIAL GAS-FIRED WATER HEATERS – HIGH EFFICIENCY, SEALED COMBUSTION

General: Provide sealed combustion, gas-fired water heaters of sizes and capacities as indicated on schedule. Product shall comply with the lead-free requirements of NSF 372, compliant with ASHRAE 90.1 and CSA and/or UL listed and are ASME labeled.

Heater: Water heater shall be gas-fired, fully condensing, operate up to a thermal efficiency of 95% or greater, equipped with control panel, power cord, CSA certified and ASME rated temperature/pressure relief valve. Storage tank construction shall be glass-lined steel with anode rod (s) or a duplex alloy (stainless steel). Water heater shall be ASME listed.

Controls and Control Panel (LCD display):

- Run history information
- Blockage sensors of vent or intake.
- Temperature range setting capability
- Self-diagnostic capabilities
- High limit control
- Remote monitoring capabilities
- Other controls based on specific manufacturer requirements

Gas Controls: Provide gas pressure regulator; modulating air/fuel valve and burner; electronic ignition.

Electrical Power: 120 V, single phase.

Condensation Neutralization kit and neutralizing tubing for each heater.

Warranty: 3 years for commercial installations

2.2 COMMERCIAL ELECTRIC WATER HEATERS – LIGHT DUTY

General: Provide UL Listed commercial electric water heaters of sizes, capacities, and electrical characteristics as indicated on schedule and compliant with the lead-free requirements of NSF 372 and ASHRAE 90.1.

Heater: Working pressure of 150 PSI, anode rod; glass lining on internal surfaces exposed to water.

Heating Elements and Control: Medium watt density, with corrosion resistant sheath, simultaneous operation, adjustable thermostat(s).

Safety Controls: Manual reset, high temperature limit control, factory wired.

Jacket: Equip with full size control compartments with front panel opening. Insulate tank with glass fiber or rigid non-CFC foam insulation. Provide outer steel jacket with baked enamel finish.

Accessories: Provide lead-free brass drain valve; CSA certified and ASME rated temperature and pressure relief valve.

Warranty: 3 year tank warranty, 1 year limited parts warranty.

2.3 EXANSION TANKS

Expansion tank shall be pre-charged, hydropneumatic steel expansion tank, stainless steel connector, rigid polypropylene liner, Butyl diaphragm, welded steel construction, air charge fitting, lead-free and NSF 61 listed and ASME stamped.

PART 3 - EXECUTION

3.0 EXAMINATION

Examine areas and conditions under which water heaters are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.1 INSTALLATION OF WATER HEATERS

General: Install water heaters in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.

Support: Place units on concrete pads, orient so controls and devices needing service and maintenance have adequate access.

Piping: Connect hot and cold water piping to units with shutoff valves and unions. Connect recirculating water line to unit or as recommended by mixing valve manufacturer piping requirements with shutoff valve, check valve, and union. Extend relief valve discharge to closest floor drain, or as indicated.

Gauges: Provide thermometers on inlet and outlet piping of water heaters, in accordance with Basic Mechanical Materials and Methods Section "Meters and Gauges".

Gas-Fired Water Heaters:

Connect gas supply 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. Comply with gas utility requirements.
Flue: Connect flue to draft hood or sealed combustion units with gas-tight connection. Provide flue of minimum size as flue outlet on heater. Refer to Division 23 sections.
Sealed combustion intake piping shall be arranged as recommended by the equipment manufacturer to eliminate freeze up conditions.

Electric Water Heaters:

Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.

Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 sections. Do not proceed with water heater start-up until wiring installation is acceptable to Water Heater Installer.

3.2 INSTALLATION OF EXPANSION TANKS

Install expansion tanks in accordance with manufacturer’s installation instructions.

Adjust pre-charge to equal incoming water pressure support independently from piping system.

Install small expansion tanks in-line with the plumbing piping. Floor mounted expansion tanks shall be mounted on a concrete housekeeping pad.

Provide isolation valve and check valve on supply piping to water heater and locate the expansion tank between the check valve and water heater. Provide an isolation valve on the branch piping to the expansion tank.

3.3 FIELD QUALITY CONTROL

Start-Up: Start-up, test, and adjust gas-fired water heaters in accordance with manufacturer's start-up instructions, and utility company's requirements. Check and calibrate controls, adjust burner for maximum efficiency.

Start-Up: Start-up, test, and adjust electric water heaters in accordance with manufacturer's start-up instructions. Check and calibrate controls.

3.4 CLOSEOUT PROCEDURES

Training: Provide services of manufacturer's technical representative for one-half day to instruct Owner's personnel in operation and maintenance of water heaters.

Schedule training with Owner, provide at least seven (7) day notice to Contractor and Engineer of training date.

END OF SECTION 22 32 00

SECTION 22 40 00
PLUMBING FIXTURES

PART 1 - GENERAL

1.0 DESCRIPTION OF WORK

Extent of Plumbing Fixtures Work required by this section is indicated on drawings and schedules and by requirements of this section.

1.1 QUALITY ASSURANCE

Codes and Standards:

ASHRAE Standard 18: "Method of Testing for Rating Drinking Water Coolers with Self-Contained Mechanical Refrigeration Systems".
ARI Standard 1010: "Drinking-Fountains and Self-Contained Mechanically- Refrigerated Drinking-Water Coolers".
ANSI Standard A117.1: "Specifications for Making Buildings and Facilities Accessible To and Usable By Physically Handicapped People".
Public Law 90-480: "Architectural Barriers Act of 1968".
International Code Council A117.1: “Accessible and Usable Buildings and Facilities”.
UL Standard 399: "Drinking-Water Systems Coolers and Health Effects".
Public Law 101-336: "Americans With Disabilities Act".
NSF Standard 61: "Drinking Water Components".
Energy Conservation Act - 1992: "Energy Conservation Standards".
ANSI Standard: Comply with ANSI Z358.1, “Emergency Eyewash and Shower Equipment”.
Uniform Plumbing Code – Comply with version enforced by the Authority Having Jurisdiction.
Safe Water Drinking Act and Amendments and includes Section 1417 requiring not more than a weighted average of 0.25 percent lead when used with respect to the wetted surfaces of pipes, pipe fittings, plumbing fittings, and fixtures.
NSF 372: “Drinking Water System Components – Lead Content”.

Where fixtures are specified as ADA Accessible, it shall be the sole responsibility for all manufacturers and/or suppliers to provide plumbing fixtures and related trim which meet or exceed the ADA Requirements.

1.2 SUBMITTALS

Submit under provisions of Division 1 and below.

Color Charts: Submit manufacturer's standard color charts for cabinet finishes and fixture colors.

Submit certification of compliance with specified NSF, ANSI, UL, and ASHRAE Standards.

Submit certification of compliance with performance verification requirements specified in this Section.

1.3 CLOSE-OUT SUBMITTALS

Submit under provisions of Division 1.

Extra Stock:

Furnish special wrenches and other devices necessary for servicing plumbing fixtures and trim to Owner with receipt in a quantity of one (1) device for each ten (10) fixtures. Furnish faucet repair kits complete with all necessary washers, springs, pins, retainers, packings, O-rings, sleeves, ceramic discs and/or seats in a quantity of one (1) kit for each forty (40) faucets.

Maintenance Data: Submit Maintenance Data and Spare Parts Lists for each type of manufactured plumbing fixtures, valves and trim. Include this data, product data, and shop drawings in Maintenance Manual; in accordance with requirements of Division 1.

PART 2 - PRODUCTS

2.0 MANUFACTURERS

Manufacturer subject to compliance with requirements, provide products by one of the following:

Lavatories, Sinks, Bidets, Service Sinks, Water Closets, Urinals, Bath Tubs, Vitreous China Surgeon Scrub Sinks, Clinical Service Sinks:

American Standard U.S. Plumbing Products
Kohler Co.
Sloan
Zurn
Toto

Stainless Steel Sinks:

Elkay Mfg. Co.
Just Mfg. Co.
Kohler Co.

Faucets – Manual Operation:

American Standard; U.S. Plumbing Products
Chicago Faucet Co.
Delta Faucet Co./Cambridge Brass
Kohler Co.
T & S Brass
Sloan Valve Co.
Symmons

Faucets – Sensor Operation:

Sloan Valve Co.
Chicago Faucet Co.
Delta Faucet Co.
T & S Brass
Kohler
American Standard

Flush Valves:

Sloan Valve Co.
Zurn Industries, Inc.

Kohler Co.
American Standard
Toto

Water Closet Seats:

Bemis Mfg. Co.
Beneke Corp.
Church Seats
Olsonite Corp.; Olsonite Seats

Water Coolers:

Elkay Mfg. Co.
Halsey Taylor Division; Household International Co.

Service Sinks:

American Standard; U.S. Plumbing Products
Crane Co.
Kohler Co.

Fixture Supports:

Josam Mfg. Co.
Wade
Jay R. Smith
Zurn Industries, Inc.

Emergency Showers, and Eye/Face Washes:

Guardian Equipment
Haws Corporation
Speakman
Bradley
Acorn Safety

Mop Service Basins

Fiat
Stern-Williams
Acorn
Florestone
Swanstone

Shower and Bath Systems and Bases:

Best Bath
Aquatic
Aqua Bath
Kohler
American Standard
Sterling (A Kohler Company)
Swanstone
Fiat
Willoughby

Florestone Products Company, Inc.
Praxis (Formerly Aquarius and Comfort Design)

Shower and Tub Trim (Thermostatic):

Powers
Leonard
Bradley

Shower and Tub Trim (Pressure Balance):

American Standard
Kohler
Powers
Symmons
Chicago Faucets
T & S Brass
Delta Faucet Co./Cambridge Brass
Bradley

Food Waste Disposers:

In-Sink-Erator
Waste King

Bed Pan Washer Faucets and Hoses:

Kohler
American Standard
Chicago Faucets
T & S Brass

Clotheswasher Machine Supply/Drain Box:

Symmons
Guy Gray
Sioux Chief

ADA Sink/Lavatory Pipe Insulation:

Truebro
Plumberex Pro-Extreme Series
Dearborn-Safety Series
McGuire – ProWrap ADA Seamless Insulator

Stainless Steel Flexible Braided Connectors for Residential Type Dishwashers only:

Brasscraft
Watts

Stops, Supplies, Drains and P-Traps:

McGuire
Dearborn
Brass Craft
Keeney Manufacturing Co.

Stainless Steel Surgeon Scrub Sinks:

Acorn
Amsco
Whitehall
Sloan
Elkay

2.1 WATER CLOSETS

Refer To Plumbing Fixture Schedule On Drawings.

2.2 URINALS

Refer To Plumbing Fixture Schedule On Drawings.

2.3 LAVATORIES

Refer To Plumbing Fixture Schedule On Drawings.

2.4 SHOWERS

Refer To Plumbing Fixture Schedule On Drawings.

2.5 SINKS

Refer To Plumbing Fixture Schedule On Drawings.

2.6 MOP SERVICE BASINS

Refer To Plumbing Fixture Schedule On Drawings.

2.7 HOSPITAL, SPECIALTY AND CLASSROOM SINKS

Refer To Plumbing Fixture Schedule On Drawings.

2.8 DRINKING FOUNTAIN

Refer To Plumbing Fixture Schedule On Drawings.

2.9 WATER COOLERS

Refer To Plumbing Fixture Schedule On Drawings.

2.10 EMERGENCY EQUIPMENT

Refer To Plumbing Fixture Schedule On Drawings.

2.11 WASHER SUPPLY AND DRAIN BOX

Refer To Plumbing Fixture Schedule On Drawings.

2.12 CARRIERS

Water Closets

Commercial grade adjustable, factory painted, cast iron face plate, support base, and appropriate type waste fitting having face plate gasket; zinc plated steel fixture studs and fasteners, coated and threaded adjustable wall coupling with neoprene closet outlet gasket, and chrome-plated fixture cap nuts and fiber fixture washers.

Wall Hung Lavatory

2.13 Commercial grade cast iron supports, having tubular steel uprights with concealed arms and sleeves, mounted on adjustable headers and complete with heavy cast iron short feet bolted to floor, alignment trusses, and mounting fasteners.

2.14 FITTINGS, TRIM, AND ACCESSORIES

Lead-free Supplies and Stops for Lavatories, Sinks and Tank-type Water Closets: Polished chrome-plated, all-brass, loose keyed angle stops with brass stems, quarter turn ball valve, having 1/2-inch inlet and 3/8-inch O.D. outlet. Kit shall include appropriate length chrome plated copper risers and chrome-plated cast or forged brass escutcheon with set screw. Quantity to match trim specified. Supplies and stops shall be certified as lead-free in accordance with NSF/ANSI 372.

Stainless Steel Flexible Braided Residential Type Dishwasher Water Connecter: Reinforced PVC inner hose braided with stainless steel, no-lead certified, rated for minimum 125 psi, at operating temperatures from 40 degrees F. to 140 degrees F., intermittent to 180 degrees F., plated brass nuts, for use in accessible locations only, IAPMO and CSA listed to ASME A112.18.6 CSA B125.6.

Traps for Drinking Fountains and Lavatories: Chrome-plated cast brass (17 gauge), 1-1/4 inch adjustable "P" trap with cleanout, chrome-plated brass (17 gauge) waste to wall and chrome-plated brass slip nuts. ADA lavatories shall have an offset tailpiece and p-trap.

Traps for Sinks: Chrome-plated cast brass (17 gauge), 1-1/2 inch adjustable "P" trap with cleanout, Chrome-plated brass (17 gauge) waste to wall and chrome-plated brass slip nuts.

Grid Drain for Lavatories: Open grid drain assembly, chrome-plated brass with 1-1/4 inch chrome-plated brass (17 gauge) tailpiece, and brass lock nut.

Grid Drain for Sinks: Flat grid drain assembly or basket type, chrome-plated brass with 1-1/2 inch chrome-plated brass (17 gauge) tailpiece, and brass lock nut.

Escutcheons: Chrome-plated cast brass or forged with set screw.

All handicapped compliant lavatories and sinks, supplies and waste, shall be insulated with molded vinyl covers, Truebro Inc. Lav-Guard Insulation Kit, or equivalent by approved manufacturer.

PART 3 - EXECUTION

3.0 EXAMINATION

Verify all dimensions by field measurements. Verify that all plumbing fixtures may be installed in accordance with pertinent codes and regulations, the original design, and the referenced standards.

Examine rough-in for potable water and waste piping systems to verify actual locations of piping connections prior to installing fixtures.

Examine walls, floors, and cabinets for suitable conditions where fixtures are to be installed.

Do not proceed until unsatisfactory conditions have been corrected.

3.1 INSTALLATION

Install plumbing fixtures level and plumb, in accordance with fixture manufacturer's written instructions, rough-in drawings, and pertinent codes and regulations, the original design, and the referenced standards.

Comply with the installation requirements of ANSI A117.1 and Public Law 90-480 with respect to plumbing fixtures for the physically handicapped. Arrange flush valve handles with proper orientation to meet ADA requirements.

Fasten plumbing fixtures securely to supports or building structure. Secure domestic water piping behind or within wall construction to provide rigid installation.

Set shower receptor and mop basins in a leveling bed of cement grout.

Install a stop valve in an accessible location in the water connection to each fixture.

Install escutcheons at each wall, floor, and ceiling penetration in exposed finished locations and within cabinets and millwork. Escutcheon shall be large enough to cover the hole cut for the pipe penetration.

Seal fixtures to walls and floors using silicone sealant as specified in Division 7. Match sealant color to fixture color.

Visible parts of fixture brass and accessories shall be chrome-plated.

External finishes on all trim shall not be chrome-plated plastic.

Where possible, fixtures shall be the product of one manufacturer. Where possible, fittings of same type shall be the product of one manufacturer.

Install hose end faucets and hose connection with vacuum breakers.

Solidly attach floor-mounted water closets to cast iron water closet flange with brass bolts, washers and nuts.

Floor mounted, back-outlet water closet sealing rings shall be as required by manufacturer.

3.2 FIELD QUALITY CONTROL

Test fixtures to demonstrate proper operation upon completion of installation and after units are water pressurized. Replace malfunctioning units, then retest.

Inspect each installed unit for damage. Replace damaged fixtures.

3.3 ADJUSTING

Adjust water pressure at drinking fountains, faucets, shower valves, and flush valves to provide proper flow and stream.

Replace washers of leaking or dripping faucets and stops.

Clean fixtures, trim, and strainers using manufacturer's recommended cleaning methods and materials.

3.4 CLEANING

Clean fixtures, trim, and strainers using manufacturer's recommended cleaning methods and materials.

3.5 PROTECTION

Provide protective covering for installed fixtures, water coolers, and trim.

Do not allow use of fixtures for temporary facilities unless expressly approved in writing by the Owner.

3.6 MOUNTING HEIGHTS SCHEDULE

Fixture mounting height and rough-in dimensions shall be as indicated on the Architectural Drawings and Specifications.

END OF SECTION 22 40 00

SECTION 23 00 00

BASIC MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.0 RELATED DOCUMENTS

Drawings and general provisions of Contract, including the General and Supplementary Conditions, Division-1 Conditions, specification sections apply to the Division 23 specifications and drawings.

Related Sections: Refer to all sections in Division 23. Refer to Division 26 specification section and Division 26 drawings.

1.1 SUMMARY

This Section specifies the basic requirements for mechanical installations and includes requirements common to more than one (1) section of Division 23. It expands and supplements the requirements specified in sections of Division 1.

1.2 ACCESSIBILITY

Install equipment and materials to provide required access for servicing and maintenance. Coordinate the final location of concealed equipment and devices requiring access with final location of required access panels and doors. Allow ample space for removal of all parts that require replacement or servicing.

Extend all grease fittings to an accessible location.

Furnish hinged steel access doors with concealed latch, whether shown on drawings or not, in all walls and ceilings for access to all concealed valves, shock absorbers, air vents, motors, fans, balancing cocks, and other operating devices requiring adjustment or servicing. Refer to Division 1 for access door specification and Division 23 for duct access door requirements.

The minimum size of any access door shall not be less than the size of the equipment to be removed or 24-inch x 24-inch if used for service only.

Furnish doors to trades performing work in which they are to be built, in ample time for building-in as the work progresses. Whenever possible, group valves, cocks, etc., to permit use of minimum number of access doors within a given room or space.

Factory manufactured doors shall be of a type compatible with the finish in which they are to be installed. In lieu of these doors, shop fabricated access doors with DuroDyne hinges may be used.

Access doors in fire-rated walls and ceilings shall have equivalent UL label and fire rating.

1.3 ROUGH-IN

Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

Refer to equipment shop drawings and manufacturer's requirements for actual provided equipment for rough-in requirements.

1.4 REQUIREMENTS OF REGULATORY AGENCIES

Refer to Division 1.

Execute and inspect all work in accordance with all Underwriters, local and state codes, rules and regulations applicable to the trade affected as a minimum, but if the plans and/or specifications call for requirements that exceed these rules and regulations, the greater requirement shall be followed. Follow recommendations of NFPA, SMACNA, EPA, OSHA and ASHRAE.

Comply with standards in effect at the date of these Contract Documents, except where a standard or specific date or edition is indicated.

The handling, removal and disposal of regulated refrigerants shall be in accordance with U.S. EPA, state and local regulations.

After entering into contract, Contractor will be held to complete all work necessary to meet these requirements without additional expense to the Owner.

1.5 REQUIREMENTS OF LOCAL UTILITY COMPANIES

Comply with rules and regulations of local utility companies. Include in bid the cost of all valves, valve boxes, meter boxes, meters and such accessory equipment which will be required for the project.

1.6 PERMITS AND FEES

Refer to Division 1.

Contractor shall pay all tap, development, meter, etc., fees required for connection to municipal and public utility facilities.

Contractor shall arrange for and pay for all inspections, licenses and certificates required in connection with the Work.

1.7 MECHANICAL INSTALLATIONS

Drawings are diagrammatic in character and do not necessarily indicate every required offset, valve, fitting, etc.

Drawings and specifications are complementary. Whatever is called for in either is binding as though called for in both.

Drawings shall not be scaled for rough-in measurements or used as shop drawings. Where drawings are required for these purposes or have to be made from field measurement, take the necessary measurements and prepare the drawings.

Before any Work is installed, determine that equipment will properly fit the space; that required piping grades can be maintained and that ductwork can be run as contemplated without interferences between systems, with structural elements or with the work of other trades.

Coordinate the installation of mechanical materials and equipment above and below ceilings with suspension system, light fixtures, and other building components.

Coordinate ceiling cavity space carefully with all trades. In the event of conflict, install mechanical and electric systems within the cavity space allocation in the following order of priority.

Plumbing waste, vent piping and roof drain mains and leaders
Supply, return and exhaust ductwork
Fire sprinkler mains and leaders
Electrical conduit
Domestic hot and cold water, medical gas piping
Fire sprinkler branch piping and sprinkler runouts

Verify all dimensions by field measurements.

Arrange for chases, slots, and openings in other building components to allow for mechanical installations.

Coordinate the installation of required supporting devices and sleeves to be set in poured in place concrete and other structural components, as they are constructed.

Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the work. Give particular attention to large equipment requiring positioning prior to closing-in the building.

Coordinate the cutting and patching of building components to accommodate the installation of mechanical equipment and materials.

Where mounting heights are not detailed or dimensioned, install mechanical services and overhead equipment to provide the maximum headroom possible.

Install mechanical equipment to facilitate maintenance and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.

Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.

1.8 EXCAVATING AND BACKFILLING

General:

Provide all necessary excavation and backfill for installation of Mechanical Work in accordance with Division 31.
In general, follow all regulations of OSHA as specified in Part 1926, Subpart P, "Excavations, Trenching and Shoring". Follow specifications of Division 23 as they refer specifically to the Mechanical Work.

Contact Owners of all underground utilities to have them located and marked, at least two (2) business days before excavation is to begin. Also, prior to starting excavation, brief employees on marking and color codes and train employees on excavation and safety procedures for natural gas lines. When excavation approaches gas lines, expose lines by carefully probing and hand digging.

Provide all necessary pumping, cribbing and shoring.

Walls of all trenches shall be a minimum of 6-inch clearance from the side of the nearest mechanical work. Install pipes with a minimum of 6-inch clearance between them when located in same trench.

Pipe Trenching:

Dig trenches to depth, width, configuration, and grade appropriate to the piping being installed. Dig trenches to 6-inches below the level of the bottom of the pipe to be installed. Install 6-inch bed of pea gravel or squeegee; mechanically tamp to provide a firm bed for piping, true to line and grade without irregularity. Provide depressions only at hubs, couplings, flanges, or other normal pipe protrusions.

Backfilling shall not be started until all work has been inspected, tested and accepted. All backfill material shall be reviewed by the Soils Engineer. In no case shall lumber, metal or other debris be buried in with backfill.

Trench Backfill:

Backfill to 12-inches above top of piping with pea gravel or squeegee, the same as used for piping bed, compact properly.
Continue backfill to finish grade, using friable material free of rock and other debris. Install in 6-inch layers, each properly moistened and mechanically compacted prior to installation of ensuing layer. Compaction by hydraulic jetting is not permissible.

After backfilling and compacting, any settling shall be refilled, tamped, and refinished at this Contractor's expense.

This Contractor shall repair and pay for any damage to finished surfaces.

Complete the backfilling near manholes using pea gravel or squeegee, installing it in 6-inch lifts and mechanically tamping to achieve 95 percent compaction.

Use suitable excavated material to complete the backfill, installed in 6-inch lifts and mechanically compacted to seal against water infiltration. Compact to 95 percent for the upper 30-inches below paving and slabs and 90 percent elsewhere.

1.9 CUTTING AND PATCHING

This Article specifies the cutting and patching of mechanical equipment, components, and materials to include removal and legal disposal of selected materials, components, and equipment.

Refer to Division 1.

Do not endanger or damage installed work through procedures and processes of cutting and patching.

Arrange for repairs required to restore other work, because of damage caused as a result of mechanical installations.

No additional compensation will be authorized for cutting and patching work that is necessitated by ill-timed, defective, or non-conforming installations.

Perform cutting, fitting, and patching of mechanical equipment and materials required to:

Uncover work to provide for installation of ill-timed work;
Remove and replace defective work;

Remove and replace work not conforming to requirements of the Contract Documents;
Remove samples of installed work as specified for testing;
Upon written instructions from the Architect, uncover and restore work to provide for Architect observation of concealed work.

1.10 TEMPORARY FACILITIES

Light, Heat, Power, Etc.:

Responsibility for providing temporary electricity, heat and other facilities shall be as specified in Division 1.

Use of Permanent Building Equipment for Temporary Heating or Cooling:

Permanent building equipment shall not be used without written permission from the Owner. If this equipment is used for temporary heating or cooling, it shall be adequately maintained per manufacturer's instructions and protected with filters, strainers, controls, reliefs, etc. The guarantee period shall not start until the equipment is turned over to the Owner for his use.

1.11 PRODUCT OPTIONS AND SUBSTITUTIONS

Refer to the Instructions to Bidders and Division 1, "PRODUCTS, OPTIONS AND SUBSTITUTION".

1.12 MECHANICAL SUBMITTALS

Refer to the Conditions of the Contract (General and Supplementary), Division 1 and AIA Document A201, "SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES".

The contractor is to prepare a submittal schedule that coincides with the overall construction schedule. This submittal schedule should include a list of individual products to be submitted under each specification section. This submittal schedule shall also include dates for anticipated review, shipment and on-site delivery times of the submitted product.

The Engineer shall be given a submittal review time of ten (10) working days upon receipt of submittal. Previous submittal rejection or revision shall not compress this review time. It shall be the contractor’s responsibility to ensure these review and/or re-review times are incorporated into the submittal schedule with enough lead time as not to affect overall construction schedule.

The manufacturer's material or equipment listed in the schedule or identified by name on the drawings are the types to be provided for the establishment of size, capacity, grade and quality. If alternates are used in lieu of the scheduled names, the cost of any changes in construction required by their use shall be borne by Contractor.

Submittals shall be prepared by authorized equipment dealers, vendors, suppliers, or representative of the products submitted. Include contact and business information of the equipment dealers, vendors, suppliers and representatives. Products and equipment submitted shall also be representative of the products and equipment to be procured and installed. General product data and shop drawings downloaded from unaffiliated websites will not be reviewed or accepted.

All equipment shall conform to the State and/or Local Energy Conservation Standards.

Submittal of shop drawings, product data, and samples will be accepted only when submitted by and stamped by the Contractor. Data submitted from subcontractors and material suppliers directly to the Architect will not be processed unless prior written approval is obtained by the Contractor.

Submit all submittal items required for each Specification Section. Submittals shall be prepared and submitted in accordance with the submittal schedule. The contractor is to determine and coordinate submittal review times, lead times and delivery times of submitted products as it coincides with the overall construction schedule. Submittals submitted in bulk or under a single division will not be reviewed and will be sent back as “revise and resubmit”.

If more than one (1) re-submittals (either for shop drawings or for as-built drawings) are made by the Contractor, the Owner reserves the right to charge the Contractor for subsequent reviews by their consultants. Such extra fees shall be deducted from payments by the Owner to the Contractor.

Before starting Work, prepare and submit to the Architect all shop drawings and descriptive equipment data required for the project. Unless each item is identified with specification section and sufficient data to identify its compliance with the specifications and drawings, the item will be returned without action or "Revise and Resubmit". Continue to submit shop drawings after each Engineer's action, until a "Reviewed" action is received. The Contractor shall submit the total number of sets as called for in Division 1 to the Architect for final distribution. Submittals shall include the following specified materials and, in addition, any materials not listed below but which are specified in the individual sections of Division 23 which follow.

Pipe Markers
Valves, including pressure relief and pressure regulating
Pumps
Tanks, including expansion
Thermometers and pressure gauges
Boilers, burners, trim and feed equipment
Piping specialties
Supports, anchors and seals
Expansion compensators
Flexible pipe connectors
Water flow meters
Insulation, including plastic pipe fitting insulation covers and manufacturer's installation instructions
Heat exchangers
Terminal heat transfer units
Air conditioning equipment and specialties
Fans, ductwork, dampers, louvers, grilles, registers and diffusers
Automatic control systems

Wiring diagrams, control panelboards, motor test data, motors, starters and controls for electrically operated equipment furnished by mechanical trades.

Identify each item with specification section and sufficient data to certify its compliance with the specifications.

Electronic submittals shall be packaged as a bookmarked multi-page single PDF file and shall not be over 5MB. Electronic Submittals over 5MB will not be accepted and will be returned un-reviewed.

1.13 REQUESTS FOR INFORMATION

All “Requests for Information” submitted by the Contractor shall include a proposed solution and an estimated cost/schedule impact. Any RFI’s that do not contain this required information will be sent back to the Contractor unanswered.

Schedule the work to provide the Engineer a minimum review time of five (5) business days upon receipt of RFIs to provide a response.

1.14 PRODUCT LISTING

Prepare listing of major mechanical equipment and materials for the project, within two (2) weeks of signing the Contract Documents and transmit to the Mechanical Engineer.

Unless otherwise specified, all materials and equipment shall be of domestic (USA) manufacture and shall be of the best quality used for the purpose in commercial practice.

Provide all information requested.

Submit this listing as a part of the submittal requirement specified in Division 1, "PRODUCTS AND SUBSTITUTION".

When two (2) or more items of same material or equipment are required (pumps, valves, air conditioning units, etc.) they shall be of the same manufacturer. Product manufacturer uniformity does not apply to raw materials, bulk materials, pipe, tube, fittings (except flanged and grooved types), sheet metal, wire, steel bar stock, welding rods, solder, fasteners, motors for dissimilar equipment units, and similar items used in work, except as otherwise indicated.

Provide products which are compatible within systems and other connected items.

1.15 NAMEPLATE DATA

Provide permanent operational data nameplate on each item of mechanical equipment, indicating manufacturer, product name, model number, serial number, efficiency rating (i.e. EER, etc.) capacity, operating and power characteristics, labels of tested compliances, and similar essential data. Locate nameplates in an accessible location.

1.16 DELIVERY, STORAGE, AND HANDLING

Refer to Division 1.

Deliver products to project properly identified with names, model numbers, types, grades, compliance labels, and similar information needed for distinct identifications; adequately packaged and protected to prevent damage during shipment, storage, and handling.

Store equipment and materials at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage, dirt, dust and moisture.

Coordinate deliveries of mechanical materials and equipment to minimize construction site congestion. Limit each shipment of materials and equipment to the items and quantities needed for the smooth and efficient flow of installations.

Provide factory-applied plastic end-caps on each length of pipe and tube, except for concrete, corrugated metal, hub-and-spigot, clay pipe. Maintain end-caps through shipping, storage and handling to prevent pipe-end damage and prevent entrance of dirt, debris, and moisture.

Protect stored pipes and tubes. Elevate above grade and enclose with durable, waterproof wrapping. When stored inside, do not exceed structural capacity of the floor.

Protect flanges, fittings, and specialties from moisture and dirt by inside storage and enclosure, or by packaging with durable, waterproof wrapping.

1.17 RECORD DOCUMENTS

Refer to Division 1. The following paragraphs supplement the requirements of Division 1.

Keep a complete set of record document prints or electronic mark-ups in custody during entire period of construction at the construction site.

Mark drawing prints to indicate revisions to piping and ductwork, size and location both exterior and interior; including locations of coils, dampers and other control devices, filters, boxes, and similar units requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; actual inverts and locations of underground piping; concealed equipment, dimensioned to column lines; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e., traps, strainers, expansion compensators, tanks, etc.); RFI's; change orders; concealed control system devices. Changes to be noted on the drawings shall include final location of any piping or ductwork relocated more than 1'-0" from where shown on the drawings.

Mark Equipment Schedules on the drawings with changes to Manufacturer, Model Number, and data based on reviewed shop drawings.

At the completion of the project, mark all valve tag numbers on the drawings and turn these drawings over to the General Contractor for his submission to the Architect and reviewed by the Architect.

1.18 OPERATION AND MAINTENANCE DATA

Refer to Division 1.

The Testing and Balancing Report shall be submitted and received by the Engineer at least five (5) calendar days prior to the Contractor's request for final observation time frame requirements. Final Observation(s) will not proceed without T&B Report. Include in the O&M Manual after review with "Review" or "Make Corrections Noted" has been accomplished.

In addition to the information required by Division 1 for maintenance data, include the following information:

Description of mechanical equipment, function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of all replaceable parts.

Manufacturer's printed operating procedures to include start-up, break-in, routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.

Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.

Servicing instructions and lubrication charts and schedules.

Manufacturer's service manuals for all mechanical equipment provided under this Contract.

Name, Address and Telephone Number of party to be contacted for twenty-four (24) hour service for each item of equipment.

Starting, stopping, lubrication, equipment identification numbers and adjustment clearly indicated for each piece of equipment.

Complete parts list.
Mechanical warranties.

This Contract will not be considered completed, nor will final payment be made, until all specified material, including Testing and Balancing Report, is received in this Operating and Maintenance Report and the manual is reviewed by the Architect.

1.19 LUBRICATION OF EQUIPMENT

Refer to Division 1. The following paragraphs supplement the requirements of Division 1.

Contractor shall properly lubricate all mechanical pieces of equipment which he provided before turning the building over to the Owner. He shall attach a linen tag or heavy duty shipping tag on the piece of equipment showing the date of lubrication and the type and brand of lubricant used.

Furnish the Engineer with a typewritten list in quadruplicate, of each item lubricated and type of lubricant used, no later than two (2) weeks before completion of the project, or at time of acceptance by the Owner of a portion of the building and the mechanical systems involved.

1.20 WARRANTIES

Refer to Division 1 for procedures and submittal requirements for warranties. Refer to individual equipment specifications for warranty requirements. In any case, the entire mechanical system shall be warranted no less than one (1) year from the time of acceptance by the Owner.

Compile and assemble the warranties specified in Division 23, into the Operating and Maintenance Manuals.

Provide complete warranty information for each item to include product or equipment to include date or beginning of warranty or bond; duration of warranty or bond; and names, addresses, and telephone numbers and procedures for filing a claim and obtaining warranty services.

1.21 CLEANING

Refer to Division 1.

Refer to Division 23, "TESTING, ADJUSTING AND BALANCING" for requirements for cleaning filters, strainers, and mechanical systems prior to final acceptance.

END OF SECTION 23 00 00

SECTION 23 01 00

M&E COORDINATION

PART 1 - GENERAL

1.0 SUMMARY

Carefully coordinate the interface between Division 23 (Mechanical) and Division 26 (Electrical) before submitting any equipment for review or commencing installation.

Responsibility: Unless otherwise indicated, all motor and controls for Division 23 equipment shall be furnished, set in place and wired in accordance with the following schedule:

COORDINATION SCHEDULE

ITEM	Furnished Under	Set in Place Under	Power Wiring Under	Control Wiring Under
Equipment Motor	23	23	26	--
Automatically Controlled Starters/Contactors:				
Separate	23	26	26	23
Factory Mounted and Wired	23	23	26	23
Manually Controlled Starter/Contactors:				
Separate	23	26	26	23
Factory Mounted and Wired	23	23	26	23
Special Duty Type Motor (Part Winding, etc.)	23	26	26	23
Disconnect Switches (Note 1)	26	26	26	--
Variable Frequency Drives	23	26	26	23
Contactors	26	26	26	--
Thermal Overload Switches (Note 1)	26	26	26	--
Manual Operating Switches (Note 2)	26	26	26	--
Control Relays (Note 2)	23	23	26	23
Control Transformers	23	23	26	23
Control Circuit Outlets	26	26	26	--
Thermostats (Note 2)	23	23	--	23
Push Button Stations, Pilot Lights (Note 2)	23	23	26	23
Thermostat and Controls Integral with Equipment or Directly Attached to Ducts, Pipes, etc. (Note 2)	23	23	26	23
Equipment in Temperature Control Panels (Note 2)	23	23	26	23
Standalone Control Panels (Note 2)	23	23	26	23
Valve Motors Damper Motors, Solenoid Valves, etc. (Note 2)	23	23	--	23
EP Valves or Switches, P.E. Switches, etc. (Note 2)	23	23	26	23
Fire Alarm System	26	26	26	26
Smoke Detectors Including Relays for Fan Control (Note 3)	26	23	26	23
Fire/Smoke Dampers	23	23	26	26
Equipment Interlock	23	23	N/A	23
Boiler	23	23	26	23
Water Heater	22	22	26	23

Notes:

(1) If furnished as part of factory wired equipment, furnish and set in place under Division 23, wiring and connections under Division 26.

(2) If float switches, line thermostats, P.E. switches, time switches, or other controls carry the FULL LOAD CURRENT to any motor, they shall be furnished and set in place under Division 23, but they shall be connected under Division 26. If they do not carry the FULL LOAD CURRENT to any motor, they shall be furnished, set in place and wired under Division 23.

(3) Wiring from alarm contacts to alarm system by Division 26; all control function wiring by Division 23. Division 23 to coordinate locations with Division 26.

Control Wiring:

Consists of wiring in pilot circuits of contactors, starters, sensors, controllers, and relays, and wiring for valve and damper operators.

Connections:

Make connections to all controls directly attached to ducts, piping and mechanical equipment with flexible connections.

Starters:

Provide magnetic starters for all three phase motors and equipment complete with:

Control transformers.
120V holding coils.
Integral hand-off auto switch.
Auxiliary contacts required for system operation plus one (1) spare.

Remote Switches and Pushbutton Stations:

Provide all remote switches and/or pushbutton stations required for manually operated equipment (if no automatic controls have been provided) complete with pilot lights of an approved type lighted by current from load side of starter.

Special Requirement:

Motor, starters and other electrical equipment installed in moist areas or areas of special conditions, such as explosion proof, shall be designed and approved for installation in such areas with appropriate enclosure.

Identification:

Provide identification of purpose for each switch and/or pushbutton station furnished. Identification may be either engraved plastic sign or permanent mounting to wall below switch, or stamping on switch cover proper. All such identification signs and/or switch covers in finished areas shall match other hardware in the immediate area.

Control Voltage:

Maximum allowable control voltage is 120V. Fully protect control circuit conductors in accordance with National Electrical Code.

Fully coordinate the requirements of each division with regard to supplying a complete DDC Control System. J-Boxes and control transformer connections shall be provided under Division 26. The transformers shall be furnished and set in place under Div. 23.

PART 2 - PRODUCTS

2.0 MOTOR HORSEPOWER

In general, all motors 3/4 HP and above shall be three phase, all motors less than 3/4 HP shall be single phase.

Voltage and phase of motors as scheduled on the electrical drawings shall take precedence in the case of a conflict between the mechanical and electrical drawings or general conditions 2.1 A., above.

Work under Division 23 includes coordinating the electrical requirements of all mechanical equipment with the requirements of the work under Division 26, before ordering the equipment.

If motor horsepowers are changed under the work of Division 23, without a change in duty of the motor's driven device, coordination of additional electrical work (if any) and additional payment for the work (if any) shall be provided under the section of Division 23 initiating the change. Increases or decreases in motor horsepower from that specified shall not be made without written approval from the Architect.

PART 3 - EXECUTION - Not used.

END OF SECTION 23 01 00

SECTION 23 05 00

COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.0 DESCRIPTION OF WORK

Extent of Piping Specialties Work required by this section is indicated on drawings and schedules and by requirements of this section.

Types of Piping Specialties specified in this section include the following:

- Escutcheons
- Mechanical Sleeve Seal
- Fire and Smoke Barrier Penetration Seal
- Drip Pan
- Pipe Sleeve
- Sleeve Seals

Piping Specialties furnished as part of factory-fabricated equipment, are specified as part of equipment assembly in other Division 23 sections.

1.1 QUALITY ASSURANCE

Manufacturer's Qualifications: Firms regularly engaged in manufacture of piping specialties of types and sizes required, whose products have been in satisfactory use in similar service for not less than five (5) years.

Codes and Standards:

ASME B 31.9 "Building Services Piping" for materials, products, and installation.
Safety valves and pressure vessels shall bear the appropriate ASME label.
Fabricate and stamp air separators and compression tanks to comply with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.
ASME "Boiler and Pressure Vessel Code," Section IX, "Welding and Brazing Qualification" for qualifications for welding processes and operators.

1.2 SUBMITTALS

Product Data: Submit manufacturer's technical product data, including installation instructions, and dimensioned drawings for each type of manufactured piping specialty. Submit schedule showing manufacturer's figure number, size, location, and features for each required piping specialty.

Shop Drawings: Submit for fabricated specialties, indicating details of fabrication, materials, and method of support.

Maintenance Data: Submit maintenance data and spare parts lists for each type of manufactured piping specialty. Include this data, product data, and shop drawings in maintenance manual; in accordance with requirements of Divisions 23.

PART 2 - PRODUCTS

2.0 MANUFACTURERS

Manufacturer: Subject to compliance with requirements, provide products by one of the following:

Pipe Escutcheons:

Chicago Specialty Mfg. Co.
Producers Specialty & Mfg. Corp.
Sanitary-Dash Mfg. Co.

Mechanical Sleeve Seal:

Thunderline Corp.
"Metraseal" by Metraflex Co.

Fire and Smoke Barrier Penetration Seal:

Electrical Products Division/3M
Dow Corning
Flame Stop, Inc.
MetaCaulk
Hilti
HoldRite

2.1 PIPE ESCUTCHEONS

General: Provide pipe escutcheons as specified herein with inside diameter closely fitting pipe outside diameter, or outside of pipe insulation where pipe is insulated. Select outside diameter of escutcheon to completely cover pipe penetration hole in floors, walls, or ceilings; and pipe sleeve extension, if any. Furnish pipe escutcheons with nickel or chrome finish for occupied areas, prime paint finish for unoccupied areas.

Pipe Escutcheons for Moist Areas: For waterproof floors, and areas where water and condensation can be expected to accumulate, provide cast brass or sheet brass escutcheons, solid or split hinged.

Pipe Escutcheons for Dry Areas: Provide sheet steel escutcheons, solid or split hinged.

2.2 MECHANICAL SLEEVE SEALS

General: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

2.3 FIRE AND SMOKE BARRIER PENETRATION SEALS

General: Provide UL Listed firestopping systems composed of components that are compatible with each other, the substrates forming openings, and the items, if any, penetrating the firestopping under conditions of service and application, as demonstrated by the firestopping manufacturer based on testing and field experience.

Provide components for each firestopping system that are needed to install fill material. Use only components specified by the firestopping manufacturer and approved by the qualified testing agency for the designated fire-resistance-rated systems.

Penetrations in Fire Resistive Rated Walls: Provide firestopping with ratings determined in accordance with UL 1479 or ASTM E 814.

F-Rating: Not less than the fire-resistance rating of the wall construction being penetrated.

Penetration in Horizontal Assemblies: Provide firestopping with ratings determined in accordance with UL 1479 or ASTM E 814.

F-Rating: Minimum of 1-hour rating, but not less than the fire-resistance rating of the floor construction being penetrated.
T-Rating: When penetrant is located outside of a wall cavity, minimum of 1-hour rating, but not less than the fire-resistance rating of the floor construction being penetrated.
W-Rating: Class 1 rating in accordance with water leakage test per UL 1479.

Penetrations in Smoke Barriers: Provide firestopping with ratings determined in accordance with UL1479 or ASTM E 814.

L-Rating: Not exceeding 5.0 cfm/sq. ft. of penetration opening at both ambient and elevated temperatures.

2.4 FABRICATED PIPING SPECIALTIES

Drip Pans: Provide drip pans fabricated from corrosion-resistant sheet metal with watertight joints, and with edges turned up 2-1/2 inch, and with double sloped to drain bottom. Reinforce top, either by structural angles or by rolling top over 1/4-inch steel rod. Provide hole, gasket, and flange at low point for watertight joint and 1-inch drain line connection. Provide drip pan overflow sensors/alarms or visual overflow piping in compliance with IMC.

Drip pans shall be located under the drainage piping at the following locations, whether these areas have ceilings or not.

Electronic Data Processing Areas
Electrical Closets
Other Sensitive Areas

Pipe Sleeves: Provide pipe sleeves of one (1) of the following:

Sheet Metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate from the following gauges: 3-inch and smaller, 20 gauge; 4-inch to 6-inch, 16 gauge; over 6-inch, 14 gauge.
Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe; remove burrs.
Iron Pipe: Fabricate from cast iron or ductile iron pipe; remove burrs.

Sleeve Seals: Provide sleeve seals for sleeves located in foundation walls below grade, or in exterior walls, of one (1) of the following:

Mechanical Sleeve Seals: Installed between sleeve and pipe.

PART 3 - EXECUTION

3.0 INSTALLATION OF PIPING SPECIALTIES

Pipe Escutcheons: Install pipe escutcheons on each pipe penetration through floors, walls, partitions, and ceilings where penetration is exposed to view; and on exterior of building. Secure escutcheon to pipe or insulation so escutcheon covers penetration hole, and is flush with adjoining surface.

Mechanical Sleeve Seals: Loosely assemble rubber links around pipe with bolts and pressure plates located under each bolt head and nut. Push into sleeve and center. Tighten bolts until links have expanded to form watertight seal.

Fire or Fire/Smoke Barrier Penetration Seals: Where pipe penetration occurs in fire or fire/smoke rated walls, provide a complete listed protection assembly equal to the rating of the wall/floor.

Provide dielectric waterways or insulating flanges, as required by pipe size, on all connections of dissimilar metals.

3.1 SLEEVES AND SEALS

Pipes:

Pipes:

New Construction: Pipes penetrating concrete or masonry construction, whether insulated or not, shall be provided with sheet metal or pipe sleeves fitted into place at time of construction. In poured concrete, the sleeves shall be steel pipe with a full circle, continuously welded water stop plate to also act as a sleeve anchor. When installing Link-Seal the sleeve and Link-Seal shall be of matched sizes. Otherwise, sleeves shall be of such size to provide all around clearance of 1/4-inch to 1-inch. Seal entire space between pipe and sleeve with fire stopping as specified in “Seals”.

Existing Construction: For existing construction or masonry construction, prepare pipe opening by carefully cutting or core drilling, install sheet metal sleeve, and fill any open space with material assembly equal to the listing of the wall. Cutting of concrete or masonry shall be done after approval of Structural Engineer.

Sleeves in non-fire rated or non-bearing walls, floors or ceilings, new or existing construction, shall be steel pipe or galvanized sheet metal with lock-type longitudinal seam. Pack all open spaces on each end with mineral wood or other non-combustible material, positively fastened in place. Asbestos is not acceptable. Where a pipe of any description passes through a concrete floor, the sleeve shall extend at least 2-inch above the finished floor, except when using the ProSet Systems.

At Contractor's option, where uninsulated pipes penetrate cast-in-place concrete floors, the "ProSet Systems," Atlanta, Georgia, sleeving may be employed.

For pipes penetrating foundation walls, water-proofing membrane floors or other places where water leakage could be encountered, install Link-Seal wall sleeves by Thunderline Corporation in manner recommended by the manufacturer.

Where pipe penetrations occur in non-fire rated floors, roof slabs, or walls, the space between pipe insert and the sleeve shall be packed on each end with mineral wool or other non-combustible material, positively fastened in place. Use plenum rated caulk to seal packing around pipe.

Seals:

General:

Seal all holes or voids where mechanical systems penetrate fire rated floors and walls with a fire stopping sealant having a fire rating equal to or greater than that of the construction being penetrated. The sealant shall meet the requirements of ASTM E-814, ASTM E-119 and UL-1479. It shall be installed with strict adherence to the manufacturer's instructions and according to the product's UL Laboratory listing. The use of asbestos in any form is not permitted.

Conduct tests according to manufacturer's written recommendations to verify that substrates are free of oil, grease, rolling compounds, incompatible primers, loose mill scale, dirt and other foreign substances capable of impairing bond of firestoping.
Do not cover firestopping with other construction until approval of authority having jurisdiction has been received.

Escutcheons:

In finished parts of the building, after painting is completed, install chromium plated escutcheons on all pipes passing through walls and floors where piping is exposed to view.

Flash and counterflash where mechanical equipment passes through weather or water-proofed walls, floors, and roofs per roof manufacturer's instructions.

3.2 INSTALLATION OF FABRICATED PIPING SPECIALTIES

Drip Pans: Locate drip pans under piping as indicated. Hang from structure with rods and building attachments, weld rods to sides of drip pan. Brace to prevent sagging or swaying. Connect 1-inch drain line to drain connection, and run to nearest plumbing drain or elsewhere as indicated.

Pipe Sleeves: Install pipe sleeves of types indicated where piping passes through walls, floors, ceilings, and roofs. Do not install sleeves through structural members of work, except as detailed on drawings, or as reviewed by Architect/Engineer. Install sleeves accurately centered on pipe runs. Size sleeves so that piping and insert will have free movement in sleeve, including allowance for thermal expansion; but not less than two (2) pipe sizes larger than piping run. Install length of sleeve equal to thickness of construction penetrated, and finish flush to surface; except floor sleeves. Extend floor sleeves 1/2-inch above level floor finish in non-equipment room areas, and 4-inch above finished floor in all Mechanical Equipment Rooms and pipe chases. Provide temporary support of sleeves during placement of concrete and other work around sleeves, and provide temporary closure to prevent concrete and other materials from entering sleeves.

Install sheet metal sleeves at interior partitions and ceilings other than suspended ceilings.
Install iron pipe sleeves at exterior penetrations; both above and below grade.
Install steel pipe sleeves except as otherwise indicated.

END OF SECTION 23 05 00

SECTION 23 05 13

MECH/ELEC REQUIREMENTS FOR MECHANICAL EQUIPMENT

PART 1 - GENERAL

1.0 DESCRIPTION OF WORK

This Section specifies the basic requirements for Electrical Components for Mechanical Equipment. These components include, but are not limited to, motors, starters, and disconnect switches for mechanical equipment.

Wiring of field-mounted switches and similar mechanical-electrical devices provided for mechanical systems, to equipment control panels.

Specific electrical requirements (i.e. horsepower and electrical characteristics) for mechanical equipment are scheduled on the Electrical Drawings. In case of conflict, Electrical Drawings shall take precedence. Do not purchase motors or electrical equipment until power characteristics available at building site location have been confirmed by Contractor.

Refer to Table in Section 23 01 00 for Mechanical/Electrical Coordination.

1.1 QUALITY ASSURANCE

Manufacturers: Firms regularly engaged in manufacture of motors, motor starters and drives of types, ratings and characteristics required, whose products have been in satisfactory use in similar service for not less than five (5) years.

Installer's Qualifications: Firm with at least three (3) years of successful installation experience on projects utilizing electric motors, motor starters, capacitors and drives similar to that required for this project.

NFPA Compliance: Comply with applicable requirements of NFPA 70E, "Standard for Electrical Safety Requirements for Employee Workplaces."

UL Compliance: Provide equipment and/or components which are UL-listed and labeled.

Standards:

NEMA Standards MG 1: Motors and Generators.
NEMA Standard ICS 2: Industrial Control Devices, Controllers, and Assemblies.
NEMA Standard 250: Enclosures for Electrical Equipment.
NEMA Standard KS 1: Enclosed Switches.
Comply with National Electrical Code (NFPA 70).

Coordination with Electrical Work: Wherever possible, match elements of electrical provisions of Mechanical Work with similar elements of Electrical Work specified in Division 26 sections. Comply with applicable requirements of Division 26 sections for Electrical Work of this section which are not otherwise specified.

1.2 SUBMITTALS

Listing, Motors of Mechanical Work: Concurrently, with submittal of mechanical products listing, submit separate listing showing rating, power characteristics, efficiencies, power factors, application and general location of every motor to be provided with mechanical work. Submit updated information promptly when and if initial data is revised.

Include in listing of motors, notations of whether motor starter is furnished or installed integrally with motor or equipment containing motor.

PART 2 - PRODUCTS

2.0 MANUFACTURERS

Subject to compliance with requirements, provide products by one of the following manufacturers for each type of product:

Motors:

Century/MagneTek
Baldor
U.S. Motor
Reliance
General Electric
Louis Allis

2.1 MOTORS

The following are basic requirements for simple or common motors. For special motors, more detailed and specific requirements are specified in the individual equipment specifications.

Torque characteristics shall be sufficient to satisfactorily accelerate the driven loads with a time limit acceptable to the motor manufacturer. Motors shall be capable of starting the driven equipment while operating at 90 percent rated terminal voltage.
Motor sizes shall be large enough so that the driven load will not require the motor to operate in the service factor range.
Starting Capability: Frequency of starts as indicated by automatic control system, and not less than five (5) evenly time spaced starts per hour for manually controlled motors.
Service Factor: 1.15 for poly-phase motors and 1.35 for single-phase motors.
Motor Construction: NEMA Standard MG 1, general purpose, continuous duty, Design "B", except "C" where required for high starting torque. Design "E" shall not be used.

Frames: NEMA Standard No. 48 or 54; Use driven equipment manufacturer's standards to suit specific application.
Bearings:

Ball bearings with inner and outer shaft seals.
Re-greasable, except permanently sealed where motor is normally inaccessible for regular maintenance.
Bearings shall be rated for minimum L-10 life of 40,000 hours.
Designed to resist thrust loading where belt drives or other drives produce lateral or axial thrust in motor.
For fractional horsepower, light duty motors, sleeve type bearings are permitted.

Enclosure Type:

Open drip-proof motors for indoor use where satisfactorily housed or remotely located during operation.
Guarded drip-proof motors where exposed to contact by employees or building occupants.
Weather protected Type I for outdoor use; Type II where not housed.

Noise Rating: "Quiet".
Efficiency: "Energy Efficient" motors shall have a minimum efficiency as scheduled in Table 1 in accordance with IEEE Standard 112, Test Method B. If efficiency not specified, motors shall have a higher efficiency than "average standard industry motors", in accordance with IEEE Standard 112, Test Method B.
Nameplate: Indicate the full identification of manufacturer, ratings, characteristics, construction, special features and similar information.

Phases and Current Characteristics: Unless indicated otherwise, provide squirrel-cage induction polyphase motors for 3/4 HP and larger, and provide capacitor-start single-phase motors for 1/2 HP and smaller, except 1/6 HP and smaller may, at equipment manufacturer's option, be split-phase type. Coordinate current characteristics with power specified in Division 26 sections. Do not purchase motors until power characteristics available at building site have been confirmed by Contractor.
The Contractor shall be responsible for all additional electrical and other costs involved to accommodate any motors which differ from the scheduled horsepower sizes or correct any motor which does not meet the listed duty or efficiency as called for in Mechanical or Electrical Plans and Specifications.
Motors shall be of the same manufacturer, except those that are an integral part of a factory assembled packaged unit. These motors shall likewise meet the conditions of the specification in this section except motors which are part of a motor/compressor assembly are exempted from this requirement.
All motors 75 HP and larger shall be factory test certified for power factor, efficiency, and shall have a three (3) year warranty. Factory certification of motor tests shall be provided to the Owner.
All equipment specified to operate with Variable Frequency Drives shall be provided with invertor-duty motors specifically designed for variable speed operation with high efficiency at part load conditions and constructed with Class F insulation.
All motors which will be operated by a Variable Frequency Drive shall be warranted against any damage or defects as a result of being used with a variable frequency drive. VFD driven motors shall have three (3) year warranties.

2.2 MOTOR ACCESSORIES

Shaft Grounding Kits: Provide shaft grounding kits for motors that operate on a VFD, and are rated at 10 HP and above.

2.3 STARTERS

Motor Starters: Refer to Section 230514.

2.4 DISCONNECT SWITCHES

See Division 26 for requirements.

2.5 DRIVES

V-Belt Drives:

Capacity of V-Belt Drives at rated RPM shall be not less than 150 percent of motor nameplate horsepower rating.
V-Belt Drive combinations shall be limited to A, B, C and fractional horsepower belts. 3V, 5V and 8V belts and sheaves shall not be used.
All fixed pitch sheaves, including single groove fan sheaves, shall be of the bushed type. Fixed bore sheaves will not be acceptable for adjustable pitch sheaves.
Unit manufacturer shall provide OSHA approved belt guard with tachometer holes.
For equipment serving hazardous or critical systems (i.e., fume hoods, bio-hazards, etc.), all fans shall have a minimum of two (2) groove sheaves and fan belts.

2.6 VARIABLE FREQUENCY DRIVES

Refer to Section 230515.

2.7 EQUIPMENT FABRICATION

General: Fabricate mechanical equipment for secure mounting of motors and other electrical items included in work. Provide either permanent alignment of motors with equipment, or adjustable mountings as applicable for belt drives, special couplings and similar indirect coupling of equipment. Provide safe, secure, durable, and removable guards for motor drives, arranged for lubrication and similar running-maintenance without removal of guards.

PART 3 - EXECUTION

3.0 TEST AND TEST DATA

A factory load test shall be performed on each motor of 1,000 watt input or greater to assure compliance with the energy-efficiency section of this specification.

Typical test data on every motor to be used on this project shall be made available upon request.

3.1 INSTALLATION

Install motors on motor mounting systems in accordance with motor manufacturer's instructions, securely anchored to resist torque, drive thrusts, and other external forces inherent in mechanical work. Secure sheaves and other drive units to motor shafts with keys and Allen set screws, except motors of 1/3 HP and less may be secured with Allen set screws on flat surface of shaft. Unless otherwise indicated, set motor shafts parallel with machine shafts.

Deliver starters and wiring devices which have not been factory-installed on equipment unit to electrical installer for installation.

Install power and control connections for motors to comply with NEC and applicable provisions of Division 26 sections. Install grounding except where non-grounded isolation of motor is indicated.

3.2 INSTALLATION COORDINATION

Furnish equipment requiring electrical connections to operate properly and to deliver full capacity at electrical service available.

All control wiring to be in accordance with manufacturer's recommendations, and shall be color-coded and individually numbered to facilitate checking.

Unless otherwise indicated, all mechanical equipment motors and controls shall be furnished, set in place, and wired in accordance with the schedule contained in Division 23. The exact furnishing and installation of the equipment is left to the Contractors involved. Contractor should note that the intent of the schedule is to have the Division 23 and 26 Contractors responsible for coordinating all control wiring as outlined, whether or not specifically called for by the Mechanical or Electrical Drawings and Specifications. Comply with the applicable requirements of Division 26 for all electrical work which is not otherwise specified. No extras will be allowed for Contractor's failure to provide for these required items. The Contractor shall refer to the Division 26 and Division 23 specifications and plans for all power and control wiring and shall advise the Architect/Engineer of any discrepancies prior to bidding.

END OF SECTION 23 05 13

SECTION 23 05 14
MOTOR CONTROLLERS

PART 1 - GENERAL

1.0 SUMMARY

Manual Motor Starters

Single Phase Motor Starters

Magnetic Motor Starters

Combination Magnetic Motor Starters

1.1 RELATED DOCUMENTS

Drawings, General and Special Conditions, Division 1 - General Requirements and other applicable technical specifications apply to work of this section.

1.2 RELATED SECTIONS

Division 26 - Electrical: All Sections.

Section 23 05 13 – Mechanical/Electrical Requirements for Mechanical Equipment.

1.3 REFERENCE STANDARDS

Comply with the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents. A listing of applicable reference standards is contained in Division 1.

ANSI/NFPA – 70, National Electrical Code

ANSI/NEMA ICS 6 – 1993: Industrial Control and Systems: Enclosures.

IEC 60947-5, 60947-4, 60947-3.

NEMA AB 1 - Molded Case Circuit Breakers.

NEMA ICS 2 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays.

UL 508, and UL 508A Industrial Control Equipment.

1.4 SUBMITTALS

Submit under provisions of Division 1.

Provide product data on motor starters and combination motor starters, relays, pilot devices, and switching and overcurrent protective devices.

1.5 OPERATION AND MAINTENANCE DATA

Submit Operation and Maintenance Data under provisions of Division 1.

Include spare parts data listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

1.6 DELIVERY, STORAGE, AND HANDLING

Deliver products to site under provisions of Division 1.

Store and protect products under provisions of Division 23.

PART 2 - PRODUCTS

2.0 ACCEPTABLE MANUFACTURERS

MOTOR STARTERS

Allen-Bradley
Cerus Industrial
Cutler Hammer
Square-D
Siemens

2.1 MANUAL MOTOR STARTERS

Manual Motor Starter: NEMA ICS 2; AC general-purpose Class A manually operated non-reversing full-voltage controller for induction motors rated in horsepower, with solid state electronic overload relay for each phase, phase loss protection, phase imbalance, ground fault protection, low-voltage protection, Red pilot light, field-convertible auxiliary contact, and toggle operator.

Fractional Horsepower Manual Starter: NEMA ICS 2; AC general-purpose Class A manually operated, full-voltage controller for fractional horsepower induction motors, with thermal overload unit, Red pilot light, and key or toggle operator as indicated.

Motor Starting Switch: NEMA ICS 2; AC general-purpose Class A manually operated pole, full-voltage controller for fractional horsepower induction motors, without thermal overload unit, Red pilot light, field convertible auxiliary contact, and toggle operator.

Enclosure: ANSI/NEMA ICS 6; Type 1 for Indoor applications, and Type 3R for Outdoor applications.

2.2 SINGLE PHASE MOTOR STARTERS

Single Phase Motor Starter Control: The single phase motor starter shall consist of a manually operated quick-make toggle mechanism lockable in the “Off” position which shall also function as the starter disconnect. Additionally, the starter shall provide thermal overload protection, run status pilot light and fault pilot light. The starter must include the capability to operate in both manual and automatic modes. In automatic modes, the starter shall have the capability to integrate with at building automation system by providing terminals for run input, run status, output and fault output. All control terminals shall be integrated in the starter. At a minimum, each single phase starter shall include an interposing run relay and current sensing status output relay. Single phase motor starter shall be in a surface mount enclosure with the appropriate environmental rating.

2.3 MAGNETIC MOTOR STARTERS

Magnetic Motor Starters: NEMA ICS 2; AC general-purpose Class A, combination type magnetic controller as specified herein, for induction motors, rated in horsepower.

Magnetic Motor Starters shall be circuit breaker or motor circuit protector combination type, with external operator, in common enclosure with starter. External circuit breaker operator environmental rating shall match the enclosure rating. Disconnecting means shall be equipped with provisions enabling locking in the "OFF" position.

Full Voltage Starting: Reversing or non-reversing type as indicated.

Coil Operating Voltage: Unless otherwise specified, 120 volts, 60 hertz.

Size: NEMA ICS 2; Size as shown on Drawings, or as required for the motor horsepower.

Overload Relay: NEMA ICS 2; self-powered, adjustable trip solid state electronic overload relay type, which protects all 3 phases with selectable trip class operation. Motor protection functions shall include: phase loss, phase unbalance, ground fault, locked rotor and stall protection.

Enclosure: NEMA ICS 6; Type 1 for Indoor applications, and Type 3R for Outdoor applications.

Auxiliary Contacts: NEMA ICS 2; two (2) field-convertible contacts, (1) NO and (1) NC, in addition to seal-in contact.

Selector Switches: NEMA ICS 2; HAND/OFF/AUTO, maintained type, in front cover

Provide manual reset push button on the starter cover to restore normal operation after a trip or fault condition.

Indicating Lights: NEMA ICS 2; RUN: Red LED type, in front cover with press-to-test lamp testing feature.

Relays: NEMA ICS 2; as required.

For 480-Volt applications, an individually fused 480-120 Volt control transformer shall be furnished with each combination starter. The Control Transformer shall be sized by the manufacturer to have a minimum of 20 percent capacity in excess of the continuous volt-ampere requirements of the holding coil, indicating lights and any externally located devices such as solenoid valves, external relays, etc. The control transformer shall be capable of operation with an inrush current twenty (20) percent greater than required by the holding coil, indicating lights and external-device, if any.

When remotely controlled by an automation system, the starter shall include remote run terminals which accept both a voltage input signal and a contact closure. The voltage run input shall accept both AC and DC signals including 24 VAC, 120 VAC, 24 VDC and 48 VDC to allow direct connection of the transistorized signal to the starter.

In applications where the motor is interlocked with a damper or valve, the actuator control must reside within the starter enclosure. The starter must provide a voltage output to operate the actuator to open the damper or valve without closing the motor circuit. The starter will only close the motor circuit and the start the motor after it has received a contact closure from a limit or end switch confirming the damper or valve position.

The starter shall provide a provision for Fireman’s Override operation. When activated, the starter runs the motor in any mode (Hand, Off or Auto) regardless of other inputs or lack of inputs either manual or automatic. The purpose of the Fireman’s Override input is to act as a smoke purge function. Fireman’s Override has priority over the Emergency Shutdown input.

If the starter is controlled by a fire alarm or life safety system, the starter shall include an Emergency Shutdown input which will disable the starter from operating in either Hand or Auto mode regardless of other inputs either manual or automatic.

Acceptable disconnecting means for combination starters include: motor circuit protectors, UL 489 circuit breakers, or a fused disconnect. All disconnects shall include a lock-out mechanism when in the off position.

The Motor Circuit protector shall be a UL listed 508 current limiting manual motor starter with magnetic trip elements only. The breaker shall carry a UL 508 rating (up to 100A frame size) which provides for coordinated short circuit rating for use with motor contactor and provides a minimum interrupting rating of 30,000 AIC for the combination starter.

Fused disconnect shall be UL 98 suitable for service entrance protection. It shall accommodate time delay J-style fuses.

UL 489 breaker shall include thermal and magnetic trip mechanisms.

Provide optional features, as required, to meet design performance according to the following requirements.

Must provide over/under voltage phase monitoring capability. Monitor shall be field adjustable for both over and under voltage levels and a delay time before returning to normal operation after trip.
Starter must measure and display output current on the front cover. If necessary, install digital or analog ammeter.
The starter shall provide the capability to monitor and calculate power consumption (kWh) of the motor load. Each starter shall display the calculated kW and kWh. Additionally, provide either a pulse output (kWh) or 4-20 mA analog signal (kW) to the automation system to monitor the power consumption.
Starter must be capable of communicating over BACnet MS/TP. At a minimum, reported points shall include starter mode, terminal input status, voltage, current, power factor, kW and kWh.

PART 3 - EXECUTION

3.0 INSTALLATION

Install motor control equipment in accordance with manufacturer's instructions.

Select and adjust electronic overloads to match installed motor characteristics.

Motor Data: Provide neatly typed label inside each motor starter enclosure door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating.

Floor mounted equipment shall be on a 4-inch concrete housekeeping pad.

Provide Nameplates per Division 26.

END OF SECTION 23 05 14

SECTION 23 05 15
VARIABLE FREQUENCY CONTROLLERS

PART 1 - GENERAL

1.0 SECTION INCLUDES

Variable Frequency Drives (VFDs)

1.1 RELATED DOCUMENTS

Drawings, General and Special Conditions, General Requirements, and other applicable technical specifications apply to work of this section.

1.2 RELATED SECTIONS

Division 26 – Electrical; All Sections

Section 23 05 13 - Mechanical/Electrical Requirements for Mechanical Equipment

Section 23 05 14 – Motor Controllers

1.3 REFERENCE STANDARDS

Comply with the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents.

NFPA 70 - National Electrical Code.

ANSI/NEMA ICS 6 - Enclosures for Industrial Controls and Systems.

NEMA AB 1 – Molded Case Circuit Breakers.

NEMA ICS 2 - Industrial Control Devices, Controllers, and Assemblies.

NEMA ICS 3.1 - Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable Speed Drive Systems.

NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

ANSI/UL Standard 508.

IEEE Standard 519-1992; For Voltage and Total Demand Distortion.

FCC Rules and Regulations, Part 15, Subpart J; For Radiated RFI.

1.4 SUBMITTALS

Submit under provisions of Division 1.

Shop Drawings: Include front and side views of enclosures with overall dimensions and weights shown; conduit entrance locations and requirements; and nameplate legends.

Product Data: Provide catalog sheets showing voltage, controller size, ratings and size of switching and overcurrent protective devices, short circuit ratings, dimensions, and enclosure details.

Test Reports: Indicate field test and inspection procedures and test results.

Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

Manufacturer's Field Reports: Submit under provisions of Division 1.

Manufacturer's Field Reports: Indicate Start-Up Inspection findings.

1.5 OPERATION AND MAINTENANCE DATA

Submit under provisions of Division 1.

Operation Data: Include instructions for starting and operating controllers, and describe operating limits that may result in hazardous or unsafe conditions.

Maintenance Data: Include routine preventive maintenance schedule.

1.6 REGULATORY REQUIREMENTS

Conform to requirements of NFPA 70.

Furnish products listed and classified by Underwriters Laboratories, Inc., and conforming to referenced standards as suitable for purpose specified and indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

Deliver products to site under provisions of Division 1.

Store, protect, and handle products under provisions of Division 23.

Accept controllers on site in original packing. Inspect for damage.

Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to components, enclosure, and finish.

1.8 FIELD MEASUREMENTS

Verify that field measurements are as on Shop Drawings.

1.9 MAINTENANCE SERVICE

Furnish service and maintenance of controller for two (2) years from Date of Substantial Completion.

1.10 EXTRA MATERIALS

Provide two (2) of each air filter.

Provide three (3) of each fuse size and type.

PART 2 - PRODUCTS

2.0 ACCEPTABLE MANUFACTURERS

All VFDs provided for this project shall be of a single manufacturer.

Approved Manufacturers:

Asea Brown Boveri (ABB)
Robicon
Danfoss
Siemens
Trane
Yaskawa

2.1 GENERAL

The VFD shall convert incoming 3-phase 60 Hz AC power to a variable frequency, variable voltage AC output suitable for control of a standard NEMA Design B induction motor over a 10:1 speed range.

The VFD shall consist of a 3-phase full-wave converter section to rectify the incoming AC source, a filtered DC bus section, and a sinusoidal PWM output section utilizing IGBT type output transistors, and utilizing sensorless torque vector control logic, as specified below.

The VFD shall maintain a near unity power factor regardless of speed or load (0.95 or better for drives larger than 5 HP).

Inverter section shall utilize insulated gate bipolar transistors (IGBTs) with a minimum rating of 1200 VDC, and have an adjustable carrier frequency range of 1 to 6 kHz through 100 HP, and 1 to 3 kHz above 100 HP.

The VFD and options shall be tested to ANSI/UL Standard 508 and listed by either UL or ETL.

Power line noise shall be limited to a 5% voltage distortion factor and total demand distortion factor (TDD) as defined in IEEE Standard 519-1992, Guide for Harmonic Control and Reactive Compensation of Static Power Converters. Submittal data shall include calculations to show TDD based on available short circuit current.

The VFD torque characteristic shall match the driven load.

The VFD shall include an integral disconnect to isolate the VFD from input power.

Voltage Tolerance: ±10%; Frequency tolerance ±3%.

The VFD output shall be rated for continuous duty with full load amp ratings that meet or exceed NEC Table 430-150. The VFD shall have overload capability of 110 percent rated current for 60 seconds. Output voltage range shall not exceed input rated voltage.

Ambient Operating Conditions: Temperature, 0-40 degrees C; Relative Humidity, 0-95 percent, non-condensing, 5600 feet elevation, without deration.

All printed circuit boards and power subassemblies shall be burned in at elevated temperature (50 degrees C minimum) for forty-eight (48) hours minimum. The completed, assembled VFD shall be functionally tested under motor load before shipment to ensure proper operation. The manufacturer shall provide certification that these tests have been completed.

2.2 BASIC FEATURES

Control power transformer with fused primary and 24V or 120V fused secondary.

VFD AC line input high-speed semi-conductor type current-limiting fuses rated 200,000 AIC minimum.

Operator Controls:

"HAND-OFF-AUTO" Selector Switch. In "AUTO' position, drive starts and stops motor from remote contact closure, and motor speed shall be proportional to a remote speed control signal. In "HAND" position, motor is started and stopped from VFD Keypad/Display Module, and the motor speed shall be as set through the VFD Keypad/Display Module.
Pilot Lights: LED Type. 22.5mm IEC Style, Red "VFD On", White "Control Power On", and Amber "VFD Fault".

Keypad/Display Module:

A multi-line alpha-numeric backlit display capable of displaying at minimum motor speed (Hz), motor current (A), motor voltage (V), elapsed time meter (Hrs.), inverter load (%) and all drive programming parameters.

Programmable Relay Outputs (three minimum) capable of indicating the following:

VFD in Run Mode
VFD at Zero Speed
VFD Fault

Terminals for field-installed external safeties.

Field-selectable Auto Restart on power source failure.

Adjustable voltage boost for starting high torque loads.

Drive shall be capable of starting into a spinning motor by matching frequency and phase angle to the motor back EMF.

Critical Speed Avoidance: Drive shall allow the User to avoid operation at resonant speeds. Selected speeds shall be stepped over. Four (4) critical speeds shall be capable of being avoided, with an adjustable bandwidth for each critical speed.

Signal Follower: In Auto Speed mode, motor speed shall be proportional to an external 4-20 ma or 0-10 vdc speed control signal. Verify with Control Contractor whether the control signal is 4-20 ma or 0-10 vdc. Provide control signal consistent throughout the facility. Loss of reference signal shall cause drive to go to programmable preset speed.

BACnet interface.

2.3 INPUT POWER HARMONIC REDUCTION

All VFDs of 3 HP and larger shall have as a minimum; positive and negative DC link reactors, or AC line input reactors to reduce input power harmonics.

2.4 MOTOR PROTECTION

For all installations where the conductors from the VFD to the motor exceed 100 feet in length, provide a minimum 3 percent reactance motor protecting dv/dt filter at the VFD output terminals.

2.5 ADJUSTMENTS

Acceleration Time: 2 to 20 Second minimum range.

Deceleration Time: 2 to 20 Second minimum range.

Volts/Hz Ratio: Programmable.

Voltage Boost: Programmable.

Critical Speed Lockout: Four (4) critical speeds with adjustable bandwidth.

Current Limit: 30 to 110 percent sine wave current rating.

Carrier Frequency Range: 1 to 6 kHz through 100 HP and 1 to 3 kHz above 100 HP.

Output Frequency Range: 0 to 80 Hz minimum range.

All drive parameters shall be stored in non-volatile memory (EEPROM).

2.6 PROTECTIVE FEATURES

VFD shall have built-in protection for power source transients, over-voltage, under-voltage, and phase loss. VFD shall not require an input isolation transformer for transient protection.

DC bus over-voltage protection.

Instantaneous shutdown when load current exceeds 150 percent.

Adjustable electronic Class 20 inverse time characteristic over-current overload protection for the motor.

The VFD shall be capable of withstanding randomly applied short circuit current applied across the output terminals without damage.

Protection of VFD for any external disconnects between the drive and the motor. Provide control terminals for connection of disconnect switch auxiliary contacts, which will immediately stop the drive when opened.

Troubleshooting Diagnostic Features:

Indicator lights on inverter power module to indicate correct operation (or failure) of individual power switching devices.
Indicator lights to show drive fault/ready states, and reason for fault shutdown, including: Instantaneous overload, motor overload, output or DC bus over-voltage, or source over-voltage, under-voltage, or phase loss. The VFD shall store in memory at minimum the previous five (5) alarms.

2.7 FABRICATION

Editor's Note: Type 12 is a dust proof Gasketed door enclosure for industrial application.

Wiring Terminations: Match conductor materials and sizes indicated.

Enclosure:

For Dry, Indoor Applications: NEMA 250, Type1.
For Wet, Indoor, Temperature Controlled Applications, NEMA 250, Type 4, with ventilation provisions, or closed loop heat exchanger, as required for adequate VFD cooling. Any powered enclosure ventilation or heat exchanger shall be configured to operate from a single point of electrical connection, common with the VFD.
For Outdoor Applications: NEMA 250, Type 4, with NEMA 250, Type 3R rain shield. In addition, provide panel heaters, and/or panel closed loop heat exchanger or panel air conditioner as required to maintain the temperature within the VFD enclosure, within the allowable operating temperature range of the VFD. Any panel heaters and/or air conditioners shall be configured to operate from a single point of electrical connection, common with the VFD.

Finish: Manufacturer's standard enamel.

2.8 SOURCE QUALITY CONTROL

Inspect and production-test each product specified in this section.

PART 3 - EXECUTION

3.0 EXAMINATION

Verify that surface is suitable for controller installation.

Do not install controller until building environment can be maintained within the service conditions required by the manufacturer.

3.1 PREPARATION

For floor-mounted VFDs, provide 4” concrete housekeeping pad.

3.2 INSTALLATION

Install controller where indicated, in accordance with manufacturer's written instructions and NEMA ICS 3.1.

Tighten accessible connections and mechanical fasteners after placing controller.

Install fuses in fusible switches.

Provide engraved plastic nameplates under the provisions of Division 26.

Provide neatly typed label inside each motor controller door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating.

Provide dry contacts for protection of VFD with external disconnect between VFD and motor.

3.3 FIELD QUALITY CONTROL

Inspect completed installation for physical damage, proper alignment, anchorage, and grounding.

3.4 START-UP SERVICE

Provide minimum two (2) hours of start-up service for each VFD. Service shall be performed by factory-trained service technicians.

Technician shall verify correct installation, start-up the drive, adjust all required operating parameters, and verify proper operation in all operating modes.

Owner Training: Provide minimum eight (8) hours training in operation and trouble-shooting procedures for the installed drives.

3.5 ADJUSTING

Make final adjustments to installed drive to assure proper operation of fan system. Obtain performance requirements from installer of driven loads.

3.6 CLEANING

Touch up scratched or marred surfaces to match original finish.

3.7 DEMONSTRATION

Provide systems demonstration under provisions of Division 26.

Demonstrate operation of controllers in automatic and manual modes.

END OF SECTION 23 05 15

SECTION 23 05 16

PIPE EXPANSION JOINTS

PART 1 - GENERAL

1.0 DESCRIPTION OF WORK

Extent of Expansion Compensation Products required by this section is indicated on drawings and/or specified in other Division 23 sections.

Types of Expansion Compensation Products specified in this section include the following:

Flexible Hose Expansion Loops
Pipe Alignment Guides:
Slip Joints:

Expansion Compensation Products furnished as part of factory-fabricated equipment, are specified as part of equipment assembly in other Division 23 sections.

1.1 QUALITY ASSURANCE

Manufacturer's Qualifications: Firms regularly engaged in manufacture of expansion compensation products of types and sizes required, whose products have been in satisfactory use in similar service for not less than five (5) years.

Codes and Standards:

EJMA Compliance: Construct expansion compensation products in accordance with standards of the Expansion Joint Manufacturer's Association (EJMA).

To assure uniformity and compatibility of piping components in grooved piping systems, all grooved products utilized shall be supplied by a single manufacturer. Grooving tools shall be supplied from the same manufacturer as the grooved components.

1.2 SUBMITTALS

Product Data: Submit manufacturer's technical product data, including installation instructions for each type of expansion compensation product. Submit expansion compensation schedule showing manufacturer's figure number, size, location, and features for each required expansion compensation product.

Shop Drawings: Submit manufacturer's assembly-type shop drawings for each type of expansion compensation product, indicating dimensions, weights, required clearances, and methods of assembly of components.

Shop Drawings: Submit shop drawings for fabricated expansion loops indicating location, dimensions, pipe sizes, and location and method of attachment of anchors.

Maintenance Data: Submit maintenance data and spare parts lists for each type of expansion compensation product. Include this data, product data, and shop drawings in Maintenance Manual; in accordance with requirements of Division 1.

PART 2 - PRODUCTS

2.0 MANUFACTURERS

Manufacturer: Subject to compliance with requirements, provide products by one of the following:

Flexible Hose Expansion Loops:

Metraflex Co.
Twin City Hose
Or Equal.

Pipe Alignment Guides:

Hyspan Precision Products,Inc.
Metraflex Co.
Keyflex, Inc.

2.1 PIPE EXPANSION JOINTS, GENERAL

Pipe expansion joints shall provide 200 percent absorption capacity of calculated piping expansion between anchors.

2.2 FLEXIBLE HOSE EXPANSION LOOPS

General: Provide flexible hose expansion loops joints where indicated for piping systems, with materials and pressure/temperature ratings selected by manufacturer to suit intended service. Select expansion joints to provide 200 percent absorption capacity with 30 percent safety factor.

Flexible hose expansion loops shall be manufactured complete with two parallel sections of corrugated metal house, compatible braid, 180º return bend, with inlet and outlet connections. Field fabricated loops shall not be acceptable.

Flexible loops shall be capable of movement in the ±X, ±Y, and ±Z planes.

Flexible hose expansion loops shall impart no thrust loads to system support, anchors or building structure.

For flammable liquid or gas service up to 4”, flexible expansion loops shall be CSA / AGA certified.

All flexible hose expansion loops shall be manufactured in accordance with the documented manufacturers weld procedure specifications in accordance with ASME Section IX.

All flexible hose expansion loops shall be manufactured in accordance with ASME / ANSI B31.1

All flexible hose expansion loops shall be listed for the service and carry the appropriate UL and FM certifications.

Flexible hose expansion loops shall have a factory supplied; hanger / support lug located at the bottom of the 180º return and shall be furnished with a plugged FPT to be used for a drain or air release vent.

Flexible hose expansion loop(s) shall be rated with an operating pressure in accordance with manufacturer’s documentation. The operating pressure shall be based on burst pressure with a 4 to 1 safety factor.

Fittings Materials of construction:

Carbon steel, Standard weight / Sch 40 ASTM A 234 WPB
End fittings shall match fittings material.
Weld end in accordance with ASME B16.9
MPT in accordance with ASME B1.20.1
Raised Face Slip on Flange in accordance with ASME B16.5
Weld neck flanges in accordance with ASME B16.5

2.3 PIPE ALIGNMENT GUIDES

General: Provide pipe alignment guides at locations and spacing indicated. Construct with 4-finger spider traveling inside guiding sleeve, with provision for anchoring to concrete substrate.

Grinnell Fig. 256
Metraflex Style IV

Guides shall be equipped with factory insulation insert, thickness to match adjoining insulation. Insulation shall be Hydrous Calcium Silicate, 1200 degree F maximum temperature, with 0.31 K-factor and

PART 3 - EXECUTION

3.0 INSPECTION

Examine areas and conditions under which expansion compensation products are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.1 EXPANSION LOOPS

Install expansion loops where indicated, at building expansion joints, and elsewhere as determined by Installer for adequate expansion of installed piping system. Install in accordance with manufacturer's instructions. Provide pipe anchors and pipe alignment guides as indicated, and in accordance with manufacturer's recommendations. Align units properly to avoid end loading and torsional stress.

3.2 INSTALLATION OF PIPE ALIGNMENT GUIDES

Install pipe alignment guides on piping that adjoins expansion joints and elsewhere as indicated.

Anchor to building substrate.

END OF SECTION 23 05 16

SECTION 23 05 19
METERS AND GAUGES

PART 1 - GENERAL

1.0 DESCRIPTION OF WORK

Extent of Meters and Gauges required by this section is indicated on drawings and/or specified in other Division 23 sections.

Types of Meters and Gauges specified in this section include the following:

Temperature Gauges and Fittings:

Glass Thermometers
Thermometer Wells
Temperature Gauge Connector Plugs

Pressure Gauges and Fittings:

Pressure Gauges
Pressure Gauge Cocks
Pressure Gauge Connector Plugs

Flow Measuring Meters:

Venturi Tube Flow Measuring Elements
Calibrated Balancing Valves

Meters and gauges furnished as part of factory-fabricated equipment are specified as part of equipment assembly in other Division 23 sections.

1.1 QUALITY ASSURANCE

Manufacturer's Qualifications: Firms regularly engaged in manufacture of meters and gauges, of types and sizes required, whose products have been in satisfactory use in similar service for not less than five (5) years.

Codes and Standards:

UL Compliance: Comply with applicable UL Standards pertaining to meters and gauges.
ANSI and ISA Compliance: Comply with applicable portions of ANSI and Instrument Society of America (ISA) Standards pertaining to construction and installation of meters and gauges.
Certification: Provide meters and gauges whose accuracies, under specified operating conditions, are certified by manufacturer.

1.2 SUBMITTALS

Product Data: Submit manufacturer's technical product data, including installation instructions for each type of meter and gauge. Include scale range, ratings, and calibrated performance curves, certified where indicated. Submit meter and gauge schedule showing manufacturer's figure number, scale range, location, and accessories for each meter and gauge.

All flow measuring devices to be provided shall be reviewed and approved by the Test and Balance Contractor for proper scale, rangeability and function prior to submitting shop drawings.

The Test and Balance Contractor shall provide a typed letter stating this review has been completed and included with shop drawing submittals.

Maintenance Data: Submit maintenance data and spare parts lists for each type of meter and gauge. Include this data and product data in Maintenance Manual; in accordance with requirements of Division 1.

PART 2 - PRODUCTS

2.0 MANUFACTURERS

Manufacturer: Subject to compliance with requirements, provide products by one of the following:

Glass Thermometers:

- Ernst Gauge Co.
- Marshalltown Instruments, Inc.
- Miljoco Corp.
- Weiss Instruments, Inc.
- Dwyer
- Trerice

Temperature Gauge Connector Plugs:

- Fairfax Company
- Peterson Equipment Co.
- Universal Lancaster
- Sisco
- MG Piping Products Co.
- Trerice

Pressure Gauges:

- Ametek/U.S. Gauge
- Marsh Instrument Co.; Unit of General Signal
- Marshalltown Instruments, Inc.
- Miljoco Corp.
- Weiss Instruments, Inc.
- MG Piping Products Co.
- Dwyer
- Trerice

Pressure Gauge Connector Plugs:

- Fairfax Company
- Peterson Equipment Co.
- Universal Lancaster
- Sisco
- MG Piping Products Co.
- Miljoco Corp.
- Trerice

Venturi Tube Flow Measuring Elements:

- Gerand
- Barco/Aeroquip Corp.

Griswold
Preso
Nexus Valve

Calibrated Balancing Valves:

"Flowset" - Flow Design, Inc.
Thrush Products, Inc.
Tour and Anderson, Inc.
Gerand "Balvalve Indicator"
Griswold
Preso
Nexus Valve

2.1 GLASS THERMOMETERS

General: Provide glass thermometers of materials, capacities, and ranges indicated, designed and constructed for use in service indicated.

Case: Die cast aluminum finished in baked epoxy enamel, glass front, spring secured, 9-inch long.

Adjustable Joint: Die cast aluminum, finished to match case, 180 degree adjustment in vertical plane, 360 degree adjustment in horizontal plane, with locking device.

Tube and Capillary: Non-Toxic spirit filled, 1 percent scale range accuracy, shock mounted.

Scale: Satin faced, non-reflective aluminum, permanently etched markings.

Stem: Copper-plated steel, or brass, for separable socket, length to suit installation.

Range: Conform to the following:

Hot Water: 30 Degree - 240 degree F with 2 degree F scale divisions (0 degree - 160 degree C with 2 degree C scale divisions).
Chilled Water: 30 - 180 Degree F with 2 degree F scale divisions (0 degree - 100 degree C with 1 degree C scale divisions).

2.2 THERMOMETER WELLS

General: Provide thermometer wells constructed of brass or stainless steel, pressure rated to match piping system design pressure. Provide 2-inch extension for insulated piping. Provide cap nut with chain fastened permanently to thermometer well.

2.3 TEMPERATURE GAUGE CONNECTOR PLUGS

General: Provide temperature gauge connector plugs pressure rated for 500 PSI and 200 degree F (93 degree C). Construct of brass and finish in nickel-plate, equip with 1/2-inch NPS fitting, with self-sealing valve core type neoprene gasketed orifice suitable for inserting 1/8-inch O.D. probe assembly from dial type insertion thermometer. Equip orifice with gasketed screw cap and chain. Provide extension, length equal to insulation thickness, for insulated piping.

2.4 PRESSURE GAUGES

General: Provide pressure gauges of materials, capacities, and ranges indicated, designed and constructed for use in service indicated.

Type: General Use, 1 percent accuracy, ANSI B40.1 Grade A, phospher bronze bourdon type, bottom connection.

Case: Stainless steel, drawn steel, or brass, glass lens, 4-1/2 inch diameter.

Connector: Brass with 1/4-inch male NPT. Provide protective syphon when used for steam service.

Scale: White coated aluminum, with permanently etched markings.

Range: Conform to the following:

Water: 0 - 100 PSI.

2.5 PRESSURE GAUGE COCKS

General: Provide pressure gauge cocks between pressure gauges and gauge tees on piping systems. Construct gauge cock of brass with 1/4-inch female NPT on each end, and "T" handle brass plug.

Syphon: 1/4-Inch straight coil constructed of brass tubing with 1/4-inch male NPT on each end.

Snubber: 1/4-Inch brass bushing with corrosion resistant porous metal disc, through which pressure fluid is filtered. Select disc material for fluid served and pressure rating.

2.6 PRESSURE GAUGE CONNECTOR PLUGS

General: Provide pressure gauge connector plugs pressure rated for 500 PSI and 200 degree F (93 degree C). Construct of brass and finish in nickel-plate equip with 1/2-inch NPS fitting, with self-sealing valve core type neoprene gasketed orifice suitable for inserting 1/8-inch O.D. probe assembly from dial type insertion pressure gauge. Equip orifice with gasketed screw cap and chain. Provide extension, length equal to insulation thickness, for insulated piping.

2.7 VENTURI TUBE FLOW MEASURING ELEMENTS

Primary flow measuring elements shall consist of Venturi tubes. Arrange piping in accordance with manufacturer's published literature. In horizontal pipes, place connections slightly above horizontal centerline of pipe.

Provide each primary element with integral tab, or metal tag on stainless steel wire, extending outside pipe covering on which is stamped or clearly printed in plainly visible position the following information:

Manufacturer's name and address.
Serial number of meter to which element is to be connected.
Name, number, or location of equipment served.
Specified rate of flow.
Multiplier (including unity, where applicable) to be applied to meter reading.

Provide taps with shutoff valves and quick connecting hose fittings for portable meters or double-ferrule compression fittings for connection to tubing for permanently located meters or recorders.

Manufacturer shall certify Venturi tubes for actual piping configuration. Any necessary piping changes required for certification shall be provided without cost to Owner. Insert type tubes may be furnished, provided they meet specification requirements in other respects.

Provide Venturi with throat diameter such that specified rate of flow will register scale reading of between 20 percent and 80 percent of full scale value.

Venturi sizes and beta ratios shall be selected so that design flow rates shall read between 20 percent and the full scale range on a linear meter (e.g. between 10-inch and 50-inch on a 0-50-inch meter), with permanent pressure loss of not more than 25 percent of indicated flow rate differential pressure.

Provide Venturi tubes of solid brass or bronze. Tubes larger than 2-inch shall have flanges or butt weld connections and may be cast iron or steel. Steel tubes may be fabricated or cast with cadmium or zinc-plating. Line throats of cast iron tubes with bronze and plate cast iron portion with cadmium.

Tubes shall be calibrated and tested by independent testing laboratory and performance data furnished with shop drawings.

Connections for attachment to portable flow meter hoses shall be readily accessible.

2.8 CALIBRATED BALANCING VALVES

General: Provide as indicated, calibrated balance valves equipped with readout valves to facilitate connecting of differential pressure meter to balance valves. Equip each readout valve with integral EPT check valve designed to minimize system fluid loss during monitoring process. Provide calibrated nameplate to indicated degree of closure of precision machined orifice. Construct balancing valve with internal EPT O-ring seals to prevent leakage around rotating element. Provide balance valves with preformed polyurethane insulation suitable for use on heating and cooling systems, and to protect balance valves during shipment.

Balancing Valve Manufacturer shall select valve sizes to provide meter readings between 7-inch and 25-inch w.g. at rated GPM.

PART 3 - EXECUTION

3.0 INSPECTION

Examine areas and conditions under which meters and gauges are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.1 INSTALLATION OF TEMPERATURE GAUGES

General: Install temperature gauges in vertical upright position, and tilted so as to be easily read by observer standing on floor.

Locations: Install in the following locations, and elsewhere as indicated:

At inlet and outlet of each hydronic boiler and chiller.
At inlet and outlet of each hydronic heat exchanger.

Thermometer Wells: Install in piping tee where indicated, in vertical upright position. Fill well with oil or graphite, secure cap.

Temperature Gauge Connector Plugs: Install in piping tee where indicated, located on pipe at most readable position. Secure cap. Provide portable temperature gauge for each plug connection.

3.2 INSTALLATION OF PRESSURE GAUGES

General: Install pressure gauges in piping tee with pressure gauge cock, located on pipe at most readable position.

Locations: Install in the following locations, and elsewhere as indicated:

At suction and discharge of each pump.

Pressure Gauge Cocks: Install in piping tee with snubber. Install syphon for steam pressure gauges.

Pressure Gauge Connector Plugs: Install in piping tee where indicated, located on pipe at most readable position. Secure cap. Provide portable pressure gauge for each plug connection.

All pressure gauges shall have coil syphon and isolation gauge cock, "snubber" valve, to service the gauge and isolate it from the pipe system service without having to drain the piping system.

For 6-Inch and Larger Piping Service, use ball valve for gauge isolation valve which shall be not less than 1/4-inch diameter for full gauge pipe correction diameter.

3.3 INSTALLATION OF FLOW MEASURING METERS

General: Install flow measuring meters on piping systems located in accessible locations at most readable position.

Calibrated Balance Valves: Install on piping with readout valves in vertical upright position. Maintain minimum length of straight unrestricted piping equivalent to three (3) pipe diameters upstream of valve.

3.4 ADJUSTING AND CLEANING

Adjusting: Adjust faces of meters and gauges to proper angle for best visibility.

Cleaning: 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.

END OF SECTION 23 05 19

SECTION 23 05 29
SUPPORTS AND ANCHORS

PART 1 - GENERAL

1.0 DESCRIPTION OF WORK

Extent of Supports and Anchors required by this section is indicated on drawings and/or specified in other Division 23 sections.

Types of Supports and Anchors specified in this section include the following:

- Piping Hangers and Supports
- Vertical-Piping Clamps
- Hanger-Rod Attachments
- Building Attachments
- Saddles and Shields
- Spring Hangers and Supports
- Miscellaneous Materials
- Anchors
- Equipment Supports

Supports and anchors furnished as part of factory-fabricated equipment are specified as part of equipment assembly in other Division 23 sections.

1.1 QUALITY ASSURANCE

Manufacturer's Qualifications: Firms regularly engaged in manufacture of supports and anchors, of types and sizes required, whose products have been in satisfactory use in similar service for not less than five (5) years.

Codes and Standards:

Regulatory Requirements: Comply with applicable Mechanical Codes pertaining to product materials and installation of supports and anchors.
Duct Hangers: SMACNA Duct Manuals.
MSS Standard Compliance:

Provide pipe hangers and supports of which materials, design, and manufacture comply with MSS SP-58.

1.2 SUBMITTALS

Product Data: Submit manufacturer's technical product data, including installation instructions for each type of support and anchor. Submit pipe hanger and support schedule showing manufacturer's figure number, size, location, and features for each required pipe hanger and support.

Shop Drawings: Submit manufacturer's assembly-type shop drawings for each type of support and anchor, indicating dimensions, weights, required clearances, and methods of assembly of components.

Product certificates signed by the manufacturer of hangers and supports certifying that their products meet the specified requirements.

Maintenance Data: Submit maintenance data and parts list for each type of support and anchor. Include this data, product data, and shop drawings in maintenance manual; in accordance with requirements of Division 1.

PART 2 - PRODUCTS

2.0 MANUFACTURERS

Manufacturer: Subject to compliance with requirements, provide products by one of the following:

Pipe Hangers and Supports:

- B-Line Systems Inc.
- Carpenter and Patterson, Inc.
- Mason Industries, Inc.
- PHD Manufacturing, Inc.
- Elcen Metal Products Company
- Erico/Caddy
- Unistrut Metal Framing Systems
- Hilti USA.
- Advanced Thermal Systems
- Anvil

Saddles and Shields:

- B-Line Systems, Inc.
- Pipe Shields, Inc.
- Erico/Caddy
- Component Products Co.
- Value Engineered Products, Inc.
- Snappitz Pipe Inserts by KB Enterprises
- Anvil

Roof Pipe Supports:

- MAPA
- Advanced Support Products
- Erico
- Mifab
- Miro Industries
- PHP Systems
- S-5
- B-Line Systems, Inc.
- Roof Top Blox

Concrete Inserts and Anchors:

- Phillips Drill Company
- Erico/Caddy
- Elcen Metal Products Company
- Ramset/Red Head
- Hilti USA.
- Star fasteners
- B-Line
- Blue Banger Hanger

2.1 PIPE HANGERS AND SUPPORTS

Hangers and support components shall be factory fabricated of materials, design, and manufacturer complying with MSS SP-58.

Components shall have galvanized coatings where installed for piping and equipment that will not have field-applied finish.
Pipe attachments shall have nonmetallic coating for electrolytic protection where attachments are in direct contact with copper tubing.

Adjustable Clevis Hanger: MSS Type 1

Steel Pipe, size 3/8-inch thru 12-inch, B-Line B3100
Copper Pipe, size 1/2-inch thru 4-inch, B-Line B3104CT

Adjustable Swivel Ring: MSS Type 10

Steel Pipe, size 1/2-inch thru 2-inch, B-Line B3170NF
Copper Pipe, size 1/2-inch thru 2-inch, B-Line B3170CT

Standard Pipe Clamps: MSS Type 8

Steel Pipe, size 3/4-inch thru 20-inch, B-Line B3373
Copper Pipe, size 1/2-inch thru 4-inch, B-Line B3373CT

Floor Stand Pipe Saddle Support: MSS Type 37

Steel Pipe, size 1 1/2-inch thru 12-inch, B-Line B3095

Steel Yoke and Pipe Roller Hanger: MSS Type 43

2-1/2 inch thru 20-inch, B-Line B3110

Hanger Rods: Continuous threaded steel, sizes as specified.

Pipe Alignment Guides:

Provide factory-fabricated guides, of cast semi-steel or heavy fabricated steel, consisting of bolted two-section outer cylinder and base with two-section guiding spider bolted tight to pipe. Size guide and spiders to clear pipe and insulation (if any), and cylinder. Provide guides of length recommended by manufacturer to allow indicated travel.

Steel Pipe, B-Line B3281 through B3287

Pipe Expansion Anchors

Steel Pipe: Metraflex Company PA-1
Steel Pipe: Field assembled expansion anchors require submitted shop drawings for review by Mechanical and Structural Engineers.

2.2 UPPER ATTACHMENTS

Beam Clamps

All thread rod sized 3/8-inch and 1/2-inch: B-Line B3034
All thread rod sizes 5/8- inch: B-Line B3033
All thread rod sizes 3/4-inch and up: B-Line B3055

2.3 CONCRETE INSERTS AND ANCHORS

Inserts: Case shall be of galvanized carbon steel with square threaded concrete insert nut for hanger rod connection; 3/4-inch lateral adjustment; top lugs for reinforcing rods, nail holes for attaching to forms. Erico Hanger Models 355 and 355N or equal Unistrut or Elcen. This type of upper attachment is to be used for all areas having poured in place concrete construction.

Anchors: Carbon steel, zinc plated Installation shall be in holes drilled with carbide-tipped drill bits or by use of self-drilling anchors.

Provide anchors suitable for the location of installation and designed to withstand all forces and movements acting in the anchor. Manufacture pipe anchors in accordance with MSS SP 58. Provide a safety factor of four (4) for the anchor installation.

Powder driven fasteners not allowed.

Self-drilling expansion shields. The load applied shall not exceed one-fourth the proof test load required.

Machine bolt expansion anchor. The load applied shall not exceed one-fourth the proof test load required.

2.4 SADDLES AND THERMAL SHIELD INSERTS AND PROTECTIVE SHIELDS

General: Provide saddles and thermal shield inserts under all insulated piping hangers. Provide thermal shield inserts on all piping through floors, wall and roof construction penetrations. Size saddles and thermal shield inserts for exact fit to mate with pipe insulation or a minimum of 1-inch thick for uninsulated pipe thermal shield inserts.

Protection Saddles: MSS Type 39; fill interior voids with segments of insulation matching adjoining insulation. For use with roller Hangers.

B-Line B3160 to B3165

Galvanized Steel Protection Shields: MSS Type 40; of length recommended by manufacturer to prevent crushing of insulation or insert. (Considering weight, use, temperature). See also Part 3.G.3.

Thermal Shield Inserts: Provide 100-psi average compressive strength, waterproof, asbestos free calcium silicate, encased with a sheet metal enclosure or other listed system manufacturers. Insert and shield shall cover the entire circumference on vertical pipes, or the bottom half circumference of the pipe on horizontal mounting supports, and shall be of length recommended by the manufacturer for pipe size and thickness of insulation or the thickness of the wall, roof or floor construction.

Thermal Mechanical Pipe Shields: Self-locking insulated pipe supports/shields shall be provided at hanger, support, and guide locations on pipe requiring insulation. The insert shall consist of either hydrous calcium silicate or polyisocyanurate foam insulation (urethane) encircling the entire circumference of the pipe. Provide with a 360 degree PVC or Galvanized steel jacket which complies with the International Mechanical Code for installation in plenum ceilings where applicable. The length of the jacket shall be sized for pipe expansion.

2.5 SPRING HANGERS AND SUPPORTS

General: Provide factory-fabricated spring hangers and supports complying with MSS SP-58, of one (1) of the following MSS types listed, selected by Installer to suit piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Use only one (1) type by one (1) manufacturer for each piping service. Select spring hangers and supports to suit pipe size and loading.

Restraint Control Devices: MSS Type 47

Spring Cushion Hangers: MSS Type 48

Spring Cushion Roll Hangers: MSS Type 49

Spring Sway Braces: MSS Type 49

Variable Spring Hangers: MSS Type 51; preset to indicated load and limit variability factor to 25 percent.

Variable Spring Base Supports: MSS Type 52; preset to indicated load and limit variability factor to 25 percent; include load flange.

Variable Spring Trapeze Hangers: MSS Type 53; preset to indicated load and limit variability factor to 25 percent.

Constant Supports: Provide one (1) of the following types, selected to suit piping system. Include auxiliary stops for erection and hydrostatic test, and field load-adjustment capability.

Horizontal Type: MSS Type 54
Vertical Type: MSS Type 55
Trapeze Type: MSS Type 56

2.6 MISCELLANEOUS MATERIALS

Steel Plates, Shapes, and Bars: ASTM A 36.

Cement Grout: Portland cement (ASTM C 150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C 404, Size No. 2). Mix ratio shall be 1.0 part cement to 3.0 parts sand, by volume, with minimum amount of water required for placement and hydration.

Heavy-Duty Steel Trapezes: Fabricate from steel shapes selected for loads required; weld steel in accordance with AWS Standards.

2.7 ROOF PIPE SUPPORTS

Factory fabricated roof support system for piping application. Base shall be compatible with roofing membrane. For support materials other than metal, such materials shall be UV resistant. All metal components shall be corrosion resistant by either galvanization or zinc plating.

Supports shall be designed to support the piping system and installed in accordance to manufacturer's requirements.

Install with supplemental pad under support base as required by roofing system design.

B-Line C-port CE Series

PART 3 - EXECUTION

3.0 INSPECTION

Examine areas and conditions under which supports and anchors are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.1 PREPARATION

Proceed with installation of hangers, supports and anchors only after required building structural work has been completed in areas where the work is to be installed. Correct inadequacies including (but not limited to) proper placement of inserts, anchors and other building structural attachments. **Review Structural Drawings to obtain structural support limitations.**

Prior to installation of hangers, supports, anchors and associated work, Installer shall meet at Project Site with Contractor, installer of each component of associated work, inspection and testing agency representatives (if any), installers of other work requiring coordination with work of this section and Architect/Engineer for purpose of reviewing material selections and procedures to be followed in performing the work in compliance with requirements specified. **Provide Shop Drawing showing method and support locations from structure.**

3.2 INSTALLATION OF BUILDING ATTACHMENTS

Install building attachments within concrete or on structural steel. Space attachments within maximum piping span length indicated in MSS SP-69 and tables this section. Install additional attachments at 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 to forms. Where concrete with compressive strength less than 2,500 psi is indicated, install reinforcing bars through openings at top of inserts.

New Construction:

Use inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams wherever practicable.
Set inserts in position in advance of concrete work. Provide reinforcement rod in concrete for inserts carrying pipe over 4-inch or ducts over 60-inch wide.
Where concrete slabs form finished ceiling, finish inserts flush with slab surface.
Use drop-in anchors for concrete structures.
Use beam clamps for steel structures.

Existing Construction:

In existing concrete construction, drill into concrete slab and insert and tighten expansion anchor bolt. Connect anchor bolt to hanger rod. Care must be taken in existing concrete construction not to sever reinforcement rods or tension wires.

3.3 INSTALLATION OF HANGERS AND SUPPORTS

Install hangers, supports, clamps and attachments to support piping properly from building structure; comply with MSS SP-69 and SP-89. Arrange for grouping of parallel runs of horizontal piping to be supported together on field fabricated, heavy-duty trapeze hangers where possible. Install supports with maximum spacings complying with MSS SP-69 and tables this section. Where piping of various sizes is supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping, and do not support piping from other piping.

Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers and other accessories.

Prevent electrolysis in support of copper tubing by use of hangers and supports which are copper plated, or by other recognized industry methods.

Install hangers and supports to allow controlled movement of piping systems, to permit freedom of movement between pipe anchors, to facilitate action of expansion joints, expansion loops, expansion bends and similar units and within 1'-0" of each horizontal elbow.

Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.

Pipe Slopes: Install hangers and supports to provide indicated pipe slopes, and so that maximum pipe deflections allowed by ANSI B31.9 Building Services Piping Code is not exceeded.

Insulated Piping: Comply with the following installation requirements:

Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed pipe stresses allowed by ANSI B31.

Saddles: Install Protection saddles MSS Type 39 where insulation without vapor barrier is indicated. Fill interior voids with segments of insulation that match adjoining pipe insulation.

Thermal Protective Metal Shields : Install thermal protective shields MSS Type 40 on cold and chilled water piping that is insulated. Thermal protective shields shall span an arc of 180 degrees and shall have dimensions in inches not less than the following:

NPS	Length	Metal Shield Thickness
1/4 thru 3-1/2	12	0.048
4	12	0.060
5 and 6	18	0.060
8 thru 14	24	0.075
16 thru 24	24	0.105

Thermal shield inserts shall be provided where thermal protective metal shields are provided and shall span an arc of 180 degrees and shall match the length of the thermal protective shield.

Install refrigerant and hydronic piping (copper and steel) hangers with the following minimum rod sizes and maximum spacing:

	Sch. 40 & Sch. 80 Steel Pipe		
Pipe Size	Maximum Hanger Spacing (ft.)	Maximum Vertical Spacing (ft.)	Minimum Rod Size (in.)
1/2"	7	15	3/8
3/4"	7	15	3/8
1"	7	15	3/8
1-1/4"	7	15	3/8
1-1/2"	9	15	3/8
2"	10	15	3/8

2-1/2"	11	15	1/2
3"	12	15	1/2
4"	12	15	5/8
5"	12	15	5/8
6"	12	15	3/4
8"	12	15	3/4
10"	12	15	7/8
12"	12	15	7/8
Based on MSS-69, IMC & IFGC.			

	Sch. 10 Stainless Steel Pipe		
Pipe Size	Maximum Hanger Spacing (ft.)	Maximum Vertical Spacing (ft.)	Minimum Rod Size (in.)
2"	8	10	3/8
2-1/2"	9	10	1/2
3"	10	10	1/2
4"	10	10	1/2
5"	10	10	1/2
6"	10	10	5/8
Based on MSS-69 & IMC.			

	Type K, L, M Copper Pipe		
Pipe Size	Maximum Hanger Spacing (ft.)	Maximum Vertical Spacing (ft.)	Minimum Rod Size (in.)
1/2"	5	10	3/8
3/4"	5	10	3/8
1"	6	10	3/8
1-1/4"	6	10	3/8
1-1/2"	8	10	3/8
2"	8	10	3/8
2-1/2"	9	10	1/2
3"	10	10	1/2
4"	10	10	1/2
5"	10	10	1/2
6"	10	10	5/8
Based on MSS-69 & IMC.			

Support vertical runs at each floor.

Install steel natural gas piping with the following minimum rod size and maximum spacing. CSST support shall be in accordance with manufacturers installation requirements:

Size (NPS)(Inches)	Maximum Span in Feet	Minimum Rod Size - Inches
1/2	6	3/8
3/4 to 1-1/4	8	3/8
1-1/2 to 2	10	3/8
2-1/2 to 3	10	1/2
4 to 5	10	5/8
6 to 8	10	3/4
10 to 12	10	7/8
Vertical, all sizes	Every floor level	

Provide copper or copper plated hangers and supports for copper piping or provide sheet lead packing between hanger or support and piping.

Place a hanger within 1-foot (0.305 m) of each horizontal elbow.

Use hangers which are vertically adjustable 1-1/2 inch (38.1 mm) minimum after piping is erected. Provide and tighten tap locking nut on each hanger.

Support vertical steel and copper piping at every story height but at not more than 15-foot intervals for steel and 10-feet for copper.

Where several pipes can be installed in parallel and at same elevation, provide trapeze hangers.

Where practical, support riser piping independently of connected horizontal piping.

Each pipe drop to equipment shall be adequately supported. All supporting lugs or guides shall be securely anchored to the building structure.

Install all couplings with torque wrench, torqued to inch-pounds as specified by the manufacturer.

Hang all insulated pipe at the point of support in the following manner:

Hanger: See Paragraph 2.2.
All insulated pipes (≥ 2"d) shall have thermal shield insert at all support points. All piping shall have thermal shield inserts at each penetration through wall, floor and roof.
Clevis Hangers: Install 180-degree waterproof, asbestos free, calcium silicate thermal shield insert with 180 degree galvanized steel protection shield.
Steel Yoke and Pipe Roll Hangers: Provide steel protection saddle welded to the pipe. Fill the voilds with fiberglass insulation.
Trapeze Hangers Utilizing Unistrut Clamps or U-Bolts: Provide 360 degree waterproof, asbestos free, calcium silicate thermal shield insert with 360 degree steel protection saddle.
All hangers shall be properly sized to accommodate the thermal shield insert and no hanger shall penetrate or crush any of the insulating material.

Install anchors and fasteners in accordance with manufacturer's recommendations and the following:

In the event a self-drilling expansion shield or machine bolt expansion shield is considered to have been installed improperly, the Contractor shall make an acceptable replacement or demonstrate the stability of the anchor by performing an on-site test under which the anchor will be subjected to a load equal to twice the actual load.
Powder-driven fasteners not allowed.
Hangers for piping and ducts shall be attached to cellular steel floor decks with steel plates and bolted rod conforming to the steel deck manufacturer's requirements. Where the individual hanger load exceeds the capacity of a single floor deck attachment, steel angles, beams or channels shall be provided to span the number of floor deck attachments required.
Welding may be used for securing hangers to steel structural members. Welded attachments shall be designed so that the fiber stress at any point of the weld or attachment will not exceed the fiber stress in the hanger rod.

3.4 INSTALLATION OF PIPE EXPANSION CONTROL ANCHORS

Install anchors at proper locations to prevent stresses from exceeding those permitted by ANSI B31.9, and to prevent transfer of loading and stresses to connected equipment.

Fabricate and install anchor by welding steel shapes, plates and bars to piping and to structure. Comply with ANSI B31.9 and with AWS Standards D1.1.

Where expansion compensators are indicated, install anchors in accordance with expansion unit manufacturer's written instructions, to control movement to compensators.

Anchor Spacings: Where not otherwise indicated, install anchors at ends of principal pipe-runs, at intermediate points in pipe-runs between expansion loops and bends. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.

3.5 SHEET METAL DUCT HANGERS AND SUPPORTS

Hanger Minimum Sizes:

Up to 30-Inch Wide: 1-inch x 16 gauge at 10-foot spacing.
31-Inch to 48-Inch Wide: 1-1/2 inch x 16 gauge at 10-foot spacing.
Over 48-Inch Wide: Trapeze hangers with angle iron and 1/2-inch rods spaced not more than 8-foot on centers.
Up to 20” round: 1-inch x 20 gauge at 10-feet spacing.
Up to 60” round: I-inch 18 gauge at 10 foot spacing.

Horizontal Duct on Wall Supports Minimum Sizes:

Up to 18-Inch Wide: 1-1/2 inch x 16 gauge or 1-inch x 1-inch x 1/8 inch at 8-foot spacing.
19-Inch to 40-Inch Wide: 1-1/2 inch x 1-1/2 inch x 1/8-inch angle at 4-foot spacing.

Vertical Duct on Wall Supports Minimum Sizes:

At 10-foot spacing.
Up to 24-Inch Wide: 1-1/2 inch x 16 gauge; 25-inch to 36-inch wide: 1-inch x 1-inch x 1/8-inch angle.
37-Inch to 48-Inch Wide: 1-1/4 inch x 1-1/4 inch x 1/8-inch angle.

Vertical Duct Floor Supports Minimum Sizes:

Riveted or screwed to duct.
Up to 60-Inch Wide: 1-1/2 inch x 1-1/2 inch x 1/8-inch angle.
Over 60-Inch Wide: 2-inch x 1/8-inch.

Provide sway bracing on all ductwork in accordance with local codes and regulations.

3.6 EQUIPMENT SUPPORTS

Fabricate structural steel stands to suspend equipment from structure above or support equipment above floor.

Grouting: Place grout under supports for piping and equipment.

Concrete bases for the mechanical equipment indoors or outdoors will be provided by the General Contractor only if shown on the Architectural or Structural Drawings. Otherwise, all bases shall be provided by this Contractor.

For Inertia Bases, see Section 23 05 48.

Housekeeping bases shall be 4-inch thick minimum, extended 4-inch beyond machinery bedplates.

This Contractor shall be responsible for the proper size and location of all bases and shall furnish all required anchor bolts and sleeves. If bases are provided by the General Contractor, furnish him with templates showing the bolt locations.

Equipment shall be secured to the bases with anchor bolts of ample size. Bolts shall have bottom plates and pipe sleeves and shall be securely imbedded in the concrete. All machinery shall be grouted under the entire bearing surface. After grout has set, all wedges, shims and jack bolts shall be removed and the space filled with non-shrinking grout. This Contractor shall provide washers at all equipment anchor bolts.

Construct equipment supports mounted above floor of structural steel members or steel pipe and fittings. Brace and fasten with flanges bolted to structure.

Provide rigid anchors for ducts and pipes immediately after vibration connections to equipment. See also Section 23 05 48.

3.7 SPIRAL LOCK SEAM DUCT HANGERS AND SUPPORTS

Round Duct Hangers Minimum Sizes:

At 10-foot spacings.
Up to 18-Inch Diameter: 1-inch x 16 gauge.
19-Inch to 36-Inch Diameter: 1-inch x 12 gauge.
37-Inch to 50-Inch Diameter: 1-1/2 inch x 12 gauge.
51-Inch to 84-Inch Diameter: Trapeze hangers with angle iron and 1/2-inch rods spaced not more than 8-foot on center.

Vertical Duct Floor Supports Minimum Sizes:

Rivet to duct and tie angles together with road, angles or cinch band.
Up to 48-Inch Wide: 1-1/2 inch x 1-1/2 inch x 1/8-inch angle.
Over 48-Inch Wide: 2-inch x 2-inch x 3/16-inch angle.

Additional Hanger Requirements:

2-Inch to 24-inch from flexible connections of fans.
2-Inch to 24-inch from the outlets or flexible connections of VAV control units or mixing boxes.
12-Inch to 36-inch from the main duct to the first hanger of long branch ducts.
2-Inch to 12-inch from the ends of all branch ducts and linear diffuser plenums.
2-Inch to 24-inch from fire or fire/smoke damper break-away joints.
Hangers at throat and heal of round or square elbows 48-inch or greater in width.

3.8 METAL FABRICATION

Cut, drill, and fit miscellaneous metal fabrications for pipe anchors and equipment supports. Install and align fabricated anchors in indicated locations.

Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

Field Welding: Comply with AWS D1.1 for procedures of manual shielded metal-arc welding, appearance and quality of welds made, methods used in correcting welding work, and the following:

Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
Obtain fusion without undercut or overlap.
Remove welding flux immediately.
Finish welds at exposed connections so that no roughness shows after finishing.

3.9 ADJUSTING

Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

Touch-Up Painting: Immediately after erection of anchors and supports, clean field welds and abraded areas of shop paint and paint exposed areas with same material as used for shop painting to comply with SSPC-PA-1 requirements for touch-up of field-painted surfaces.

Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils.

For galvanized surfaces, clean welds, bolted connections and abraded areas and apply galvanizing repair paint to comply with ASTM A 780.

END OF SECTION 23 05 29

SECTION 23 05 48
VIBRATION CONTROL

PART 1 - GENERAL

1.0 DESCRIPTION OF WORK

Extent of Vibration Control Work required by this section is indicated on Drawings and Schedules, and/or specified in other Division 23 sections.

Types of Vibration Control Products specified in this section include the following:

- Fiberglass Pads and Shapes
- Neoprene Pads
- Vibration Isolation Springs
- All-Directional Anchors
- Neoprene Mountings
- Spring Isolators, Vertically-Restrained
- Isolation Hangers
- Inertia Base Frames
- Riser Isolators
- Flexible Pipe Connectors

Vibration Control Products furnished as integral part of factory-fabricated equipment, are specified as part of equipment assembly in other Division 23 sections.

Refer to other Division 23 sections for equipment foundations; Hangers; Sealants; Gaskets; requirements of electrical connections to equipment isolated on vibration control products; requirements of duct connections to air handling equipment isolated on vibration control products.

1.1 QUALITY ASSURANCE

Manufacturer's Qualifications: Firms regularly engaged in manufacture of vibration control products, of type, size, and capacity required, whose products have been in satisfactory use in similar service for not less than five (5) years.

- Except as otherwise indicated, obtain Vibration Control Products from single manufacturer.
- Engage Manufacturer to provide technical supervision of installation of support isolation units produced, and of associated inertia bases (if any).

1.2 SUBMITTALS

Product Data: Submit manufacturer's technical product data and installation instructions for each type of vibration control product. Submit schedule showing size, type, deflection, and location for each product furnished.

- Include data for each type and size of unit, showing isolation efficiency, stiffness, natural frequency and transmissibility at lowest operating speed of equipment.
- For spring units, show wire size, spring diameter, free height, solid-compression height, operating height, fatigue characteristics, ratio of horizontal to vertical stiffness and bases of spring-rated selection for range of loading weights.
- Include performance certifications from manufacturers.

Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weights, required clearances, and method of assembly of components. Detail bases and show location of equipment anchoring points coordinated with equipment manufacturer's shop drawings.

Shop drawings showing structural design and details of inertia bases, steel beam bases and other custom-fabricated work not covered by manufacturer's submitted data.

Furnish templates, anchor bolts and sleeve for equipment bases, foundations and other support systems for coordination of vibration isolation units with other work.

Submit shop drawings indicating scope of vibration isolation work and locations of units and flexible connections. Include support isolation points for piping and ductwork including risers, air housings and inertia bases.

Include schedule of units, showing size or manufacturer's part number, and weight supported and resulting deflection of each unit.

Maintenance Data: Submit maintenance data for each type of vibration control product. Include this data, product data and shop drawings in maintenance manual; in accordance with requirements of Division 1.

PART 2 - PRODUCTS

2.0 ACCEPTABLE MANUFACTURERS

Manufacturer: Subject to compliance with requirements, provide products by one of the following:

Vibration Control Products:

Mason Industries, Inc.
Kinetics Noise Control.
Vibration Eliminator
Senior Flexonics
Amber Booth

2.1 VIBRATION CONTROL MATERIALS AND SUPPORT UNITS

Fiberglass Pads and Shapes: Glassfiber of not more than 0.18 mil diameter, produced by multiple-flame attenuation process, molded with manufacturer's standard fillers and binders through ten (10) compression cycles at three (3) times rated load bearing capacity, to achieve natural frequency of not more than 12 Hertz, in thicknesses and shapes required for use in vibration isolation units.

Neoprene Pads: Oil-resistant neoprene sheets of manufacturer's standard hardness and cross-ribbed or waffled pattern.

Mason Industries Type W

Vibration Isolation Springs: Wound-steel compression springs, of high-strength, heat-treated, spring alloy steel with outside diameter not less than 0.8 times operating height; with lateral stiffness not less than vertical stiffness and designed to reach solid height before exceeding rated fatigue point of steel.

Color coated springs for ease of identification.
Spring shall have a minimum of 50 percent additional travel to solid.

Mason Industries Type SLF

All-Directional Anchors: Provide all-directional acoustical pipe anchor consisting of telescopic arrangement of sizes of steel tubing separated by minimum 1/2-inch thickness of heavy-duty neoprene and duck, or neoprene isolation material. Provide vertical restraints by similar material arranged to prevent vertical travel in either direction. Design for maximum 500 PSI load on isolation materials, and provide for equal resistance in any direction. Equip anchor with threaded hole on top and two (2) holes in base plate for bolting down or provide welding provisions top and bottom, if indicated.

Mason Industries Type ADA

Neoprene Mountings: Provide neoprene mountings consisting of neoprene element bonded between two (2) steel plates that are neoprene-covered to prevent corrosion. Provide minimum rated deflection of 0.35-inch. Provide threaded hole in upper plate and two (2) holes in base plate for securing to equipment and to substrate.

Mason Industries Type ND

Spring Isolators, Vertically-Restrained: Provide spring isolators Type C in housing that includes vertical limit stops. Design housing to act as blocking during erection, and with installed height and operating height being equal. Maintain 1/2-inch minimum clearance around restraining bolts, and between housing and springs. Design so limit stops are out of contact during normal operation.

Mounting used outdoors shall be hot dipped galvanized, spring shall be cadmium plated.
Mounting used outdoors shall have certified calculation by a registered professional engineer showing ability to withstand 109 MPH wind load in three (3) principal axis.

Mason Industries Type SLRS or Type SLR

Isolation Hangers: Hanger units formed with brackets and including manufacturer's standard compression isolators of type indicated. Design brackets for five (5) times rated loading of units. Fabricate units to accept misalignment of 15 degree off center in any direction before contacting hanger box, and for use with either rod or strap type members, and including acoustical washers to prevent metal-to-metal contacts.

Provide vibration isolation spring Type C with cap in lower pad-type isolator rubber hanger element in bottom, securely retained in unit.
Provide neoprene element, with minimum deflection of 0.35-inch, securely retained in hanger box.

Mason Industries Type 30N

Riser Isolators: Suspend risers from, or support risers by, spring hangers Type ND or spring isolators Type F. Wherever possible, anchor risers at central point with resilient anchors, Type D. Provide hanger or mounting deflection of 0.75-inch except in those expansion locations where additional deflection is required to limit deflection or load changes to +25 percent of initial deflection. Provide sliding guides held in position by resilient anchors, located between anchor points and end of piping, spaced as indicated.

Inertia Base Frames: Where inertia bases are indicated for use with isolation units to support equipment, provide rectangular structural beam channel, or complete sheet metal box concrete forms for floating foundations, with materials complying with ASTM A36. Frame unit as shown or, if not shown, with minimum depth of 0.08 x longest dimension of base, but not less than 6-inch deep. Size frame as shown or, if not shown, so that weight of frame plus concrete fill will be greater than operating weight of equipment supported. Provide steel reinforcing both ways with both ends of reinforcing buttwelded to base framing.

Provide welded support brackets and anchor base frame to spring isolator units.
Provide anchor bolts, located as required for equipment anchorage and supported for casting of concrete. Locate bolts as indicated or, if not indicated, locate bolts so that operating weight of equipment will be centered both ways on inertia base.
Provide adjustable bolts in pipe sleeves.
Provide mounting bracket to provide 1-inch floor clearance.

Flexible Pipe Connectors:

For Non-Ferrous Piping, provide bronze hose covered with bronze wire braid with copper tube ends or bronze flanged ends, braze-welded to hose.

Mason Industries Type BBF

Flexible Pipe Connectors: Provide EDPM construction consisting of multiple plies of Kevlar cord fabric and elastomer molded and peroxide cured in hydraulic rubber presses, rated for 125 PSI at 220 degree F (104 degree C).

Mason Industries Type SFDEJ

PART 3 - EXECUTION

3.0 INSPECTION

Examine areas and conditions under which vibration control units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Owner or his representative.

3.1 PERFORMANCE OF ISOLATORS

General: Comply with minimum static deflections recommended by ASHRAE, for selection and application of vibration isolation materials and units as indicated.

Manufacturer's Recommendations: Except as otherwise indicated, comply with manufacturer's recommendations for selection and application of vibration isolation materials and units to achieve minimum static deflection and displacement requirements.

3.2 APPLICATIONS

Editor’s Note: Refer to the ASHRAE table reference below and edit the specification and details accordingly. Do not rely on the Contractor to select the proper vibration isolation.

General: Except as otherwise indicated, select vibration control products in accordance with ASHRAE Handbook, 2011 HVAC Applications Volume, Chapter 48 "Sound and Vibration Control", Table 47.

Piping: For piping connected to equipment mounted on vibration control products, install isolation hangers Type N, as indicated, and for first three (3) points of support for pipe sizes 4-inch and less, for first four (4) points of support for pipe sizes 6-inch through 8-inch, and for first six (6) points of support for pipe sizes 10-inch and over.

3.3 INSTALLATION

General: Except as otherwise indicated, comply with manufacturer's instructions for installation and load application to vibration isolation materials and units. Adjust to ensure that units do not exceed rated operating deflections or bottom out under loading, and are not short-circuited by other contacts or bearing points. Remove space blocks and similar devices (if any) intended for temporary protection against overloading during installation.

Install units between substrate and equipment as required for secure operation and to prevent displacement by normal forces.

Adjust leveling devices as required to distribute loading uniformly onto isolators. Shim units as required where substrate is not level.

Install inertia base frames on isolator units so that minimum of 1-inch clearance below base will result when frame is filled with concrete and supported equipment has been installed and loaded for operation.

Locate isolation hangers as near overhead support structure as possible.

Weld riser isolator units in place as required to prevent displacement from loading and operations.

Flexible Pipe Connectors: Install on equipment side of shutoff valves, horizontally and parallel to equipment shafts wherever possible.

3.4 EXAMINATION OF RELATED WORK

Installer of vibration isolation work shall observe installation of other work related to vibration isolation work, including work connected to vibration isolation work; and, after completion of other related work (but before equipment start-up), shall furnish written report to Engineer listing observed inadequacies for proper operation and performance of vibration isolation work. Report shall cover, but not necessarily be limited to the following:

Equipment installations (performed as work of other sections) on vibration isolators.
Piping connections, including flexible connections.
Ductwork connections, including provisions for flexible connections.
Passage of piping and ductwork, which is to be isolated through walls and floors.

Do not start-up equipment until inadequacies have been corrected in manner acceptable to vibration isolation installer.

3.5 ADJUSTING AND CLEANING

Clean each vibration control unit, and verify that each is working freely, and that there is no dirt or debris in immediate vicinity of unit that could possibly short-circuit unit isolation.

3.6 DEFLECTION MEASUREMENTS

Upon completion of vibration isolation work, prepare report showing measured equipment deflections theoretical floor deflection and isolation efficiency for each major item of equipment.

END OF SECTION 23 05 48

SECTION 23 05 53

MECHANICAL IDENTIFICATION

PART 1 - GENERAL

1.0 DESCRIPTION OF WORK

Extent of Mechanical Identification Work required by this section is indicated on drawings and/or specified in other Division 23 sections.

Types of Identification Devices specified in this section include the following:

- Plastic Pipe Markers
- Plastic Tape
- Underground-Type Plastic Line Marker
- Engraved Plastic-Laminate Signs
- Plasticized Tags
- Lettering and Graphics

Refer to other Division 23 sections for Identification Requirements at Central-Station Mechanical Control Center; not work of this section.

Refer to Division 26 sections for Identification Requirements of Electrical Work; not work of this section.

1.1 QUALITY ASSURANCE

Manufacturer's Qualifications: Firms regularly engaged in manufacturer of identification devices of types and sizes required, whose products have been in satisfactory use in similar service for not less than five (5) years.

Codes and Standards:

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

1.2 SUBMITTALS

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

Schedules: Submit valve schedule for each piping system, typewritten and reproduced on 8-1/2" x 11" bond paper. Tabulate valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), size of valve, and variations for identification (if any). Only tag valves which are intended for emergency shutoff and similar special uses, such as valve to isolate individual system risers, individual floor branches or building system shut-off valves. In include in Operation & Maintenance Manuals as specified in Division 1.

PART 2 - PRODUCTS

2.0 MANUFACTURERS

Manufacturer: Subject to compliance with requirements, provide products by one of the following:

- Brady (W.H.) Co.; Signmark Division
- Brimar Industries, Inc.

Industrial Safety Supply Co., Inc.
Seton Name Plate Corp.
Kolbi.

2.1 MECHANICAL IDENTIFICATION MATERIALS

General: Provide manufacturer's standard products of categories and types required for each application as referenced in other Division 23 sections. Where more than single type is specified for application, selection is Installer's option, but provide single selection for each product category.

2.2 PLASTIC PIPE MARKERS

Snap-On Type: Provide manufacturer's standard pre-printed, semi-rigid snap-on, color-coded pipe markers, complying with ANSI A13.1.

Insulation: Furnish 1-inch thick molded fiberglass insulation with jacket for each plastic pipe marker to be installed on uninsulated pipes subjected to fluid temperatures of 125 degree F (52 degree C) or greater. Cut length to extend 2-inch beyond each end of plastic pipe marker.

Small Pipes: For external diameters less than 6-inch (including insulation if any), provide full-band pipe markers, extending 360 degrees around pipe at each location, fastened by one (1) of the following methods:

Snap-on application of pre-tensioned semi-rigid plastic pipe marker.
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 inch.

Large Pipes: For external diameters of 6-inch and larger (including insulation if any), provide either full-band or strip-type pipe markers, but not narrower than three (3) times letter height (and of required length), fastened by one (1) of the following methods:

Steel spring or non-metallic fasteners.
Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 1-1/2 inch wide; full circle at both ends of pipe marker, tape lapped 3-inches.
Strapped-to-pipe (or insulation) application of semi-rigid type, with manufacturer's standard stainless steel bands.

Lettering: Comply with piping system nomenclature as specified, scheduled, shown, or to match existing building lettering nomenclature system and abbreviate only as necessary for each application length.

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 TAPE

General: Provide manufacturer's standard color-coded pressure-sensitive (self-adhesive) vinyl tape, not less than 3 mils thick.

Width: Provide 1-1/2 inch wide tape markers on pipes with outside diameters (including insulation, if any) of less than 6-inch, 2-1/2 inch wide tape for larger pipes.

Color: Comply with ANSI A13.1, except where another color selection is indicated.

2.4 UNDERGROUND-TYPE PLASTIC LINE MARKERS

General: Manufacturer's standard permanent, bright-colored, continuous-printed plastic tape, intended for direct-burial service; not less than 6-inch wide x 4 mils thick. Provide tape with printing which most accurately indicates type of service of buried pipe.

Provide multi-ply tape consisting of solid aluminum foil core between 2-layers of plastic tape.

2.5 ENGRAVED PLASTIC-LAMINATE SIGNS

General: Provide engraving stock melamine plastic laminate, complying with FS L-P-387, in the sizes and thicknesses indicated, engraved with engraver's standard letter style of the sizes and wording indicated, Black with White core (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.

Thickness: 1/8-Inch, except as otherwise indicated.

Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.

2.6 PLASTICIZED TAGS

General: Manufacturer's standard pre-printed or partially pre-printed accident-prevention tags, of plasticized card stock with matt finish suitable for writing, approximately 3-1/4 inch x 5-5/8 inch, with brass grommets and wire fasteners, and with appropriate pre-printed wording including large-size primary wording (As examples; DANGER, CAUTION, DO NOT OPERATE).

2.7 LETTERING AND GRAPHICS

General: Coordinate names, abbreviations and other designations used in mechanical identification work, with corresponding designations shown, specified, scheduled and approved by the Owner/Engineer. Provide numbers, lettering and wording as indicated and approved by the Owner/Engineer for proper identification and operation/maintenance of mechanical systems and equipment.

Multiple Systems: Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as designated on the drawings or schedule as well as service.

PART 3 - EXECUTION

3.0 GENERAL INSTALLATION REQUIREMENTS

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.

3.1 PIPING SYSTEM IDENTIFICATION

General: Install pipe markers of the following type on each system indicated to receive identification, and include arrows to show normal direction of flow. Existing building identification shall match the existing method which exists in the building.

Plastic pipe markers, with application system as indicated under "MATERIALS" in this section. Install on pipe insulation segment where required for hot non-insulated pipes.

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

Provide identification labels on each ceiling grid or ceiling access door for control device and equipment located above ceiling.

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.

Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures.

At access doors, manholes and similar access points which permit view of concealed piping.

Near major equipment items and other points of origination and termination.

Spaced intermediately at maximum spacing of 25-foot along each piping run, except reduce spacing to 15-foot in congested areas of piping and equipment.

On piping above removable acoustical ceilings.

3.2 UNDERGROUND PIPING IDENTIFICATION

General: During back-filling/top-soiling of each exterior underground piping systems, install continuous underground-type plastic line marker, located directly over buried line at 6-inch to 8-inch below finished grade. Where multiple small lines are buried in common trench and do not exceed overall width of 16-inch, install single line marker. For tile fields and similar installations, mark only edge pipelines of field.

3.3 MECHANICAL EQUIPMENT IDENTIFICATION

General: Install minimum 2-inch x 4-inch engraved plastic laminate equipment marker on each individual items of mechanical equipment. Provide signs for the following general categories of equipment.

Main building systems control and operating valves, including safety devices and hazardous units such as gas outlets.
Room thermostats, except gun tag labels are acceptable for room thermostats.
Fuel-burning units including boilers, furnaces, heaters.
Pumps, compressors, chillers, condensers and similar motor-driven units.
Heat exchangers and similar equipment.
Fans and blowers.
HVAC units.
Tanks and pressure vessels.
Water treatment systems and similar equipment.

Lettering Size: Minimum 1/4-inch high lettering for name of unit.

Text of Signs: In addition to the identified unit, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.

3.4 ADJUSTING AND CLEANING

Adjusting: Relocate any mechanical identification device which has become visually blocked by work of this division or other divisions.

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

END OF SECTION 23 05 53

SECTION 23 05 93

TESTING, ADJUSTING & BALANCING

PART 1 - GENERAL

1.0 RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Divisions 1 and 23 Specification sections, apply to work of this section.

1.1 DESCRIPTION OF WORK

This section covers Testing and Balancing of Environmental Systems including but not limited to air distribution systems, hydronic distribution systems, and the equipment and apparatus connected thereto. The testing and balancing of all environmental systems shall be the responsibility of one (1) testing, balancing and adjusting firm.

Test, Adjust, and Balance all of the following mechanical systems:

Supply Air Systems;
Return Air Systems;
Exhaust Air Systems;
Hydronic Systems;
Pumps;
Refrigeration Equipment;
Temperature Control System;
Heat Generating Equipment;
Engine Generator System;

Report any systems for excessive sound and vibration levels.

1.2 QUALIFICATIONS OF CONTRACTOR

Procure the services of an independent testing and balancing Agency specializing in the testing, adjusting and balancing of environmental systems to perform the above mentioned work. An independent agency is defined as an organization that is not engaged in engineering design or is not a division of a mechanical contractor entity that installs mechanical systems. It shall be an agency certified by NEBB or TABB. Testing and balancing work shall be directly supervised by a NEBB certified Supervisor or Professional Engineer on the Testing and Balancing Agency's staff. The Supervisor shall represent the Testing and Balancing Agency in progress meetings as requested, and shall be available for interpreting all material found in the Balance Report.

All field work shall be performed by qualified technicians who are currently certified by either NEBB or TABB Test and Balance Certification Agencies.

1.3 CONTRACTOR QUALIFICATIONS REVIEW

The Mechanical Contractor shall submit the name of the Testing and Balancing Agency to the Architect within thirty (30) days of contract award to ensure that the Testing and Balancing Agency is on the project from the outset of construction.

1.4 CODES AND STANDARDS

ASHRAE: ASHRAE Handbook 2011, Applications Volume, Chapter 36, Testing, Adjusting, and Balancing.

NEBB: "Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems."

SMACNA: “Tab Procedure Guidelines”.

1.5 SUBMITTALS

Upon award of the Contract, the Contractor shall submit the name of the Test and Balance Agency who will be performing the work. The submittal shall include a complete list of all technicians who will be performing the field work and include a photocopy of their current certification by either NEBB or TABB Certification Agencies.

Only those technicians included in the submittal shall perform the work. Any personnel or staff used to perform the work who are not included in the submittal shall be grounds for rejecting the Test and Balance Report and the Project in whole.

1.6 PROJECT CONDITIONS

Air and water testing and balancing shall not begin until the system has been completed and is in full working order.

Put all heating, ventilating and air conditioning systems and equipment into full operation and continue operation of same during each working day of testing and balancing. Preliminary Testing and Balancing requirements shall be ascertained prior to the commencement of work through a review of the project plans and specifications. In addition, visual observations at the site during construction shall be made to determine the location of required balancing devices, that they are being installed properly, and in an accessible location for the need. Report in writing any deficiencies to the Contractor and Mechanical Engineer immediately.

Before any air balance work is done, the system shall be checked for duct leakage, assure filters are installed, see that filters are changed if they are dirty, check for correct fan rotation, equipment vibration, and check automatic dampers for proper operation. All volume control dampers and outlets shall be wide open at this time.

Before any hydronic balancing work is done, the system shall be checked for plugged strainers, proper pump rotation, proper control valve installation and operation, air locks, proper system static pressure to assure a full system, proper flow meter and check valve installation. All throttling devices and control valves shall be open at this time.

1.7 SEQUENCING AND SCHEDULING

Coordinate scheduling of Work with the Contractor.

Schedule TABB work to coincide with testing and verification of the temperature control systems where practical.
Coordinate system start-up and performance verification with the Engineer as TABB work is in progress.

Provide written notification to the Project Manager five (5) working days prior to commencing TABB and a schedule for completing the work.

Provide written notification to the Contractor within twenty-four (24) hours of an equipment failure preventing TABB work from proceeding.

PART 2 - PRODUCTS

2.0 INSTRUMENTS

Calibration and maintenance of instruments shall be in accordance with manufacturer's standards.

Calibration histories for each instrument shall be available for examination.

Use a true RMS amp and harmonic distortion electrical test meter to test and record operating and performance measurements for all motors operating with variable frequency drives.

PART 3 - EXECUTION

3.0 TEMPERATURE CONTROLS

Operate all temperature control systems with the Temperature Control Contractor's representative for proper sequence of operation and calibration. Report in writing any deficiencies to the Engineer immediately.

3.1 REQUIREMENTS OF WORK

Provide all necessary fan belts and sheaves to balance all fans to the specified air delivery for the actual field conditions.

Test and Balance Agency shall provide motor sheave replacement and fan belt and sheave replacement necessary for final balance condition for specified air quantity when the VFD is operating at design conditions. Motor sheaves shall be replaced so motors operate at rated rpm at 60HZ, then fan sheaves shall be replaced to meet design requirements at 60HZ, without placing the motor over its nameplate amp rating.
The Test and Balance report shall include voltage readings, both into the VFD, with concurrent motor amp readings.

Balance all air and water flows at terminals within +5 percent to -5 percent of design flow quantities for individual terminals. And +10 percent to –5 percent of individual air outlets or inlets. Measure and record the following data:

Air Balance:

Air supply, return and exhaust systems with air quantities for each air device; air handling units including supply, return, mixed, and outside temperatures and fan data including CFM, static pressure, fan RPM, voltage, rated motor amperage, motor running amperage before and after final balance, listed motor power factor and motor running power factor reading. Air diffusion patterns shall be set to minimize objectionable drafts, noise, and local smoke detection device ratings.

The supply, return and exhaust fan static pressure shall be set by the balancing firm and the Control Contractor if the systems have fan volume control. The duct static shall be confirmed both through the instrumentation installed on the job and by the Balancing Agency. The system shall be tested in all operating modes (including minimum outside air with full return air, full outside air, modulated damper position, and full cooling with the design diversity). System static pressure and fan motor amperages shall be recorded in all modes. The fan speed resulting in satisfactory system performance shall be determined at full design delivery, inlet or outlet fan. Volume control dampers shall be in the wide open position and variable frequency drive is at 100 percent of design RPM and one (1) path presenting the greatest resistance to flow shall be fully open and unobstructed.

Provide full pitot traverse and CFM measurements at each fan in addition to terminal device measurements.

Air volume and air temperature rise or drop across each coil, filter, dampers, etc., of air handling section.

Measure, adjust, set, balance and record outside air, return air and exhaust/relief air quantities for all air handling systems and supply fans.

Air quantities shall be determined by direct airflow measuring procedures wherever possible, where duct/inlet conditions do not allow for accurate direct measurement of outside air the following method shall be used:

Outside Air CFM = Supply Fan Total CFM
-Return Fan Total CFM

In addition to the direct measuring of airflow quantities, measure and record outside air, return air and mixed air temperatures, determine thermal/mass energy balance and provide calculations to verify measured airflow quantities. Adjusting and setting the outside air quantity as a percentage of damper position will not be acceptable.

Final adjustments shall include but not be limited to the following:

ITEM	**ADJUSTMENT**
Fan: Belt Drive	RPM. Include sheave and belt exchange to deliver air flow within limits of installed motor horsepower and mechanical stress limits of the fan. Determine the limiting fan tip speed before increasing RPM. Final fan speed setting shall allow for predicted filter loading and shall establish proper duct pressures for operation of zone CFM regulators.
Fan: Direct Drive	RPM with speed taps. Set fan speed on tap which most closely approaches design CFM. Report tap setting on equipment data sheet as high, medium or low. RPM with speed control rheostat. Set output of fan at design CFM by adjusting the SCR. After adjustment, check fans ability to re-start after powering down. Increase setting if required for proper starting.
Terminal Boxes	VAV and Constant Volume Boxes with Reheat. Set regulators to provide design maximum, minimum, heating and cooling CFM.
Air Devices	All diffusers and registers shall be measured and balanced.
Motor Starter Thermal Heaters	Division 23 Furnished Magnetic and Manual Starters. Furnish and exchange thermals as required for proper motor protection.

	Division 26 Furnished Motor Control Center Magnetic Starters. Check for correct sizing. Notify Electrical Contractor of discrepancies. Existing Magnetic and Manual Starters. Furnish and exchange thermals as required for motor protection.
Variable Frequency Drives	Test, measure and record true RMS amperage, THD for voltage and amperage for each variable frequency drive at both the input power to the drive and the output power to the motor in both the drive mode and through the across the line by-pass mode.

Hydronic Balance:

Heat exchanger inlet and outlet water temperatures and pressures with corresponding system

Inlet and outlet water temperatures and pressures of all air handling unit coils, reheat coils, unit heaters, convectors, finned tube radiation, and other heat transfer equipment, as well as the corresponding media flows, and air temperature rise or drops.

Chiller inlet and outlet water temperatures, inlet and outlet evaporator and condenser pressures, motor running amperage, refrigerant temperature.

Circulating pump flow rates, pressures, running amperage, and full load amperage at design flow and shutoff conditions.

The hydronic system shall be proportionally balanced being certain that the path to one (1) terminal is fully open. Total system flow shall be adjusted at the pump by restricting the discharge balancing valve. If the pump must be severely restricted, the impeller may have to be trimmed. This decision will be the responsibility of the Contractor, Supplier, and the Mechanical Engineer.

When necessary as determined by the Mechanical Engineer, the Test and Balance Agency shall provide additional testing and measurements as required by the Mechanical Engineer including, but not limited to, the following:

Static pressure gradient profiles throughout ductwork and/or piping systems.

Temperature gradient profiles throughout ductwork and/or piping system.

Miscellaneous electrical measurements.

Smoke tests of room pressure relationships.

This work shall be done immediately upon request with complete cooperation and in an expedient schedule at no additional cost to any other party.

3.2 REPORT OF WORK

The Testing and Balancing Agency shall submit the final Testing and Balancing Report at least five (5) calendar days prior to the Contractor's request for final inspection. All data shall be recorded on applicable reporting forms. The report shall include all operating data as listed in Paragraph 3.2 above, a list of all equipment used in the testing and balancing work, and shall be signed by the Supervising Registered Professional Engineer and affixed with their registration stamp, signed and dated in accordance with State Law. Final acceptance of this project will not take place until a satisfactory report is received.

When deemed necessary by the Mechanical Consulting Engineer, the Testing and Balancing Agency shall run temperature and/or humidity recordings and shall read any of the report quantities in the presence of the Engineer for verification purposes.

When all air balancing is done and all dampers are set, all test holes shall be plugged and all dampers shall be marked with paint. The following information shall be recorded for each fan system in the final report: Design fan and air device inlet or outlet size, actual inlet or outlet size, design and actual CFM and velocity through the orifice, for each terminal in the system. The pitot tube traverse method used and location of pitot tube traverse for determining CFM shall be recorded.

Hydronic Systems With Meters: The system shall be balanced proportionally using the flow meters. On completion of the balance, the following information shall be recorded in the report: Flow meter size and brand, required flow rate and pressure drop, valve settings on meters with a readable scale, flow rate in both full coil flow and full bypass modes. Verify the meters are installed per the manufacturer's recommendations and shall notify the Contractor of any deficiencies before utilizing meter.

Hydronic Systems without Meters (Thermal or Terminal Rated Pressure Drop Balance): The system shall be balanced proportionally to the terminal ratings. On completion of the balance, the following information shall be recorded in the report: Design entering and leaving water temperature/pressure drop, final balanced entering and leaving water temperature/pressure drop.

When all hydronic balancing is done, all valves shall be marked or the locking rings set. Control valve bypass loops shall be set with the balancing valve to provide equal flow in either mode. Confirm in writing this work has been completed.

After all balancing is complete and all coordination with the Contractor and the Engineer is complete, the balancing firm shall furnish aforementioned bound report which shall contain the following information:

RPM, drive sheave information (as installed and as changed), fan nameplate information, motor nameplate information, motor amperage, motor voltage and power factor to all motors (in all operating modes).
Static pressure across all components of the system.
Required and final balanced CFM at each system terminal. Include the terminal size, reading orifice size, and velocities read to attain the CFM.
Indicate on which terminal (on each system) has been balanced100% open as required in the previous sections for both air and hydronic balancing.
Pump and motor nameplate information, amperage and voltage to all motors, pressure drop across all system terminals, pressure rise across the pump in PSI and feet of head.
Thermal protection for all motors shall be recorded; also power factor for all motors drawing 1,000 watts or more. Starter brand, model, enclosure type, installed thermal heaters and the rating of the heaters, required thermal heaters and the rating of the heaters if different than installed shall be recorded. Starter heaters shall be changed to the correct size and so noted in the report. If the starters were furnished by the Division 26, the correct heater sizes shall be noted in the report and the Contractor shall be advised.

The report shall include a sheet which shall report the method of balance, project altitude, and any correction factors.

A **complete** reduced set of the **Black-line** Mechanical Contract Drawings which shall be included in the report with all equipment, flow measuring devices, terminals (VAV boxes, outlets, inlets, coils, unit heaters, fintube loops, radiant panel loops, schedules, etc.) clearly marked and all equipment designated.

Include in the report all variable frequency drive electrical performance test characteristics for each motor as described in this specification section. Include photocopies of all meter chart recorded <measured data> and/or computer printed output.

The Testing and Balancing Agency shall respond and correct all deficiencies within seven (7) days of receiving the Engineer's written review of the Balancing Report. Failure to comply will result in holding retainage of the final payment until all items have been corrected to the satisfaction of the Engineer.

3.3 GUARANTEE OF WORK

The Testing and Balancing Agency shall guarantee the accuracy of the tests and balance for a period of ninety (90) days from date of final acceptance of the Test and Balance Report. During this period, the Testing and Balancing Agency shall make personnel available at no cost to the Owner to correct deficiencies that may become apparent in the system balance.

3.4 COMPLETION SERVICES

Final Check: Make final checks and do any rebalancing as directed.

Report: Submit Balancing Report as specified above, to the Owner. Submit preliminary copy of report to Engineer for spot-checking as described below.

Acceptance: Notify Engineer and Owner that work is complete and submit preliminary copy of Balancing Report. Schedule time to meet the Owner and Engineer at the site to perform spot-checking and verification as directed. Test and Balance Agency shall furnish personnel and equipment and spot check:

The TAB representative shall be a member of the same team used during the original testing.

Equipment used during the random testing shall be the same equipment used during the original testing.

The system or equipment being verified shall be in the same operating mode as during the original TAB test.

Up to 10 percent of the air readings shall be re-tested. Ninety percent (90%) of the re-tested readings must be within tolerances of the specifications.

Up to 20 percent of the balanced hydronic component readings shall be re-tested. Ninety percent (90%) of the re-tested readings must be within tolerances of the specifications.

Whenever system verifications do not meet specifications, the entire system shall be re-balanced and rechecked.

END OF SECTION 23 05 93

SECTION 23 07 00

MECHANICAL INSULATION

PART 1 - GENERAL

1.0 DESCRIPTION OF WORK

This Section includes:

- Piping Insulation, Jackets and Accessories
- Ductwork Insulation and Jackets
- Equipment Insulation and Covering

Refer to other Division 23 sections for Shields, Inserts, and Mechanical Identification.

1.1 QUALITY ASSURANCE

Manufacturer's Qualifications: Firms regularly engaged in manufacture of mechanical insulation products, of types and sizes required, whose products have been in satisfactory use in similar service for not less than three (3) years.

Installer's Qualifications: Firm with at least five (5) years successful installation experience on projects with mechanical insulations similar to that required for this project.

Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics and insulating cements.

1.2 SUBMITTALS

Product Data: Submit manufacturer's installation instructions and schedule listing materials, thickness, K-value, density, and furnished accessories for each service or equipment specified.

1.3 DELIVERY, STORAGE, AND HANDLING

Deliver insulation, coverings, cements, adhesives, and coatings to site in containers with manufacturer's stamp or label, affixed showing fire hazard ratings of the products, name of manufacturer, and brand.

Protect insulation against dirt, water, chemical, and mechanical damage.

PART 2 - PRODUCTS

2.0 MANUFACTURERS

Manufacturer: Subject to compliance with requirements, provide product by one of the following:

Insulation:

- Armaflex
- Johns-Manville Products Corp. (fiberglass, calcium silicate)
- Knauf Fiber Glass (fiberglass)
- Manson Insulation Co. (fiberglass, calcium silicate)
- Owens-Corning Fiberglas Corp. (fiberglass)
- Rubatex Corp. (flexible elastomeric)
- Aeroflex (flexible elastomeric)
- Roxul (Mineral Wool)

Jacketing, Coatings, Adhesives, Sealants and Covering Products:

Childers
Foster
Johns-Manville Products Corp.
Knauf Fiber Glass
3M Company Venture Tape
Design Polymetrics
PIC Plastics

2.1 PIPING INSULATION

Glass Fiber: ASTM C 547, Type 1, rigid molded, noncombustible, 0.23 "K" value at 75 degree F mean temperature, maximum service temperature 850 degree F, moisture sorption less than 0.2% by volume. Composite 25/50-flame spread/smoke developed rating (ASTM E 84, UL 723, and NFPA 255).

Vapor Retarder Jacket: ASTM C 1136, 45lbs/in tensile strength (ASTM D 828), or beach puncture 50 oz in/in tear minimum (ASTM D 781). White Kraft paper reinforced with glass fiber yarn and bonded to aluminum foil, secured with self-sealing longitudinal laps and butt strips.
Connections: Tacks, pressure sensitive color matching vinyl tape, Perma-Weld adhesive.

Calcium Silicate: ASTM C 533, Type I, rigid molded, noncombustible (ASTME E 136), 0.42 "K" value at 300 degree F mean temperature, maximum service temperature 1200 degree F, 160 psi compressive strength for 5 percent compression (ASTM C 165), flexural strength 70 psi (ASTM C 203). 0/0 flame spread/smoke developed rating (ASTM E 84).

Tie Wire: 16-Gauge stainless steel with twisted ends on maximum 12-inch centers.

Flexible Elastomeric Foam: ASTM C 534, Type I, flexible, cellular elastomeric, molded, 0.27 "K" value at 75 degree F mean temperature, maximum service temperature 220 degree F, water vapor permeability of 0.10 perm-inch, 25/50-flame spread/smoke developed rating (ASTM E 84, UL 723, and NFPA 255).

Mineral Wool: ASTM C 547, Type 1, Type IV, molded, 0.34 K value at 300 degree F mean temperature, maximum service temperature 1000 degree F, moisture sorption less than 0.2% by volume. Composite 25/50-flame spread/smoke developed rating (ASTM E 84, UL 723, and NFPA 255).

Vapor Retarder Jacket: ASTM E 96, 68lbs/in tensile strength (PSTC-31). 5-ply weather and abuse resistant jacketing, secured with self-sealing longitudinal lap.

Field Applied Fittings and Jackets:

PVC Plastic:

One-piece, gloss white, molded fitting covers with factory installed fiberglass insulation inserts.
20 Mil (30 mil for exterior applications) cut and curled gloss white jacketing material. Composite 25/50 flame spread/smoke developed rating (ASTM E84).
Connect with tacks and pressure sensitive color matching vinyl tape.

Canvas: UL Listed fabric, 6 oz/sq yd, plain weave cotton treated with dilute fire retardant lagging adhesive. Lagging adhesive shall be Foster 30-36, Childers CP 50 AMV1 or Duct Mate Lag it.

Aluminum: 0.016-Inch thick sheet with factory applied moisture barrier, smooth finish, with longitudinal slip joints and 2-inch laps, die shaped fitting covers.
Stainless Steel: Type 304 stainless steel, 0.010-inch.

2.2 DUCTWORK INSULATION

Rigid Fiberglass Board: ASTM C 612, Type IA and IB, 3 lb/cu ft density, 0.23 "K" value at 75 degree F mean temperature, maximum service temperature 450 degree F, moisture sorption less than 5.0% by weight, aluminum foil facing reinforced with fiberglass scrim laminated to UL rated Kraft paper. Composite 25/50-flame spread/smoke developed rating (ASTM E 84, UL 723, and NFPA 90A).

Secure with UL listed pressure sensitive tape and/or outward clinched expanded staples and vapor barrier mastic as needed.

Flexible Fiberglass Blanket: ASTM C 553, Type II, 3/4 lb/cu ft density, 2 inch thickness, 0.25 "K" value at 75 degree F mean temperature at compressed thickness, maximum service temperature 250 degree F, moisture sorption less than 0.2% by volume, aluminum foil facing reinforced with fiberglass scrim laminated to UL rated Kraft paper. Composite 25/50-flame spread/smoke developed rating (ASTM E 84, UL 40, and NFPA 90A).

Secure with UL Listed pressure sensitive tape and/or outward clinched expanded staples and vapor barrier mastic as needed.

Flexible Elastomeric Foam: ASTM C 534, Type I, flexible, cellular elastomeric, molded, 0.27 "K" value at 75 degree F mean temperature, maximum service temperature 220 degree F, water vapor permeability of 0.10 perm-inch, 25/50-flame spread/smoke developed rating (ASTM E 84, UL 723, and NFPA 255).

Field Applied Jackets: ASTM C 921, Type I for ductwork with temperatures below ambient, Type II for ductwork with temperatures above ambient.

Aluminum: 0.016-inch thick sheet with factory applied moisture barrier, with longitudinal slip joints and 2-inch laps, die shaped fitting covers.

Laminated Foil/Film Jacketing: "Venture Clad Plus" by Venture Tape Corporation.

Product shall meet UL723 50/75 Flame Spread/Smoke Rating, zero permeability (ASTM E96), absolute weather and vapor barrier.
Product shall be 15.5 mills thickness, with 80 lb puncture resistance (ASTM D1000).
Finish shall be Natural Aluminum**.**

Ductwork Insulation Accessories: Provide staples, bands, wires, tape, anchors, corner angles and similar accessories as recommended by insulation manufacturer for applications indicated.

Ductwork Insulation Coating, Mastics, Adhesives and Sealants:

Vapor Barrier Coating (Store and apply between 40°F and 100°F, protect from freezing until dry): Used on below ambient piping/duct to prevent moisture ingress. Permeance shall be 0.013 perms or less at 43 mils dry per ASTM E 96, Procedure B.

Foster 30-80
Childers CP-38
Vimasco 749

Weather Barrier Mastic (Store and apply between 40° F and 100° F, protect from freezing until dry): Used on above ambient piping/duct outdoors.

Fosters 46-50
Childers CP-10/11
Vimasco WC-5

Lagging Adhesive/Coating (Store and apply between 40° F and 100° F, protect from freezing until dry): Comply with MIL-A-3316C, Class 1, Grade A.

Foster 30-36
Childers CP-50AHV2
Vimasco 713

Fiberglass Adhesive (Store and apply between 40° F and 100° F, protect from freezing until dry): Comply with ASTM C916, Type II.

Foster 85-60
Childers CP-127
Vimasco 795

Metal Jacketing/Flashing Sealant (Store and apply between 40° F and 100° F, protect from freezing until dry): Used to seal metal jacketing laps against water entry and to flash penetrations.

Foster 95-44
Childers CP-76
Pittsburgh Corning PC 727

Reinforcing Mesh: Used in conjunction with coatings and mastics.

Foster Mast a Fab
Childers Chil Glas #10
Vimasco Elast a Fab

Self-Adhesive Indoor/Outdoor Jacket (Non Asphaltic): Vapor barrier and waterproofing jacketing for installation over insulation located aboveground outdoors or indoors. Specialized jacket with five layers of laminated aluminum and polyester film with low temperature, acrylic, pressure sensitive adhesive; outer aluminum surface coated with UV resistant coating for protection from environmental contaminants. Permeance: 0.00 perm as tested by ASTM F 1249. Flame Spread <25, Smoke Developed <50 tested by ASTM E-84. Embossed Aluminum finish.

Round Ducts and Concealed Rectangular Ducts: Adhere flexible insulation to ductwork with adhesive applied in 6-inch wide strips on 16-inch centers. Butt insulation and seal joints and breaks with 2-inch lap of foil adhered over joint.

2.3 EQUIPMENT INSULATION

Rigid Fiberglass Board (Low Temperature): ASTM C 612, Type IA and IB, 3 lb/cu ft density, 0.23 "K" value at 75 degree F mean temperature, maximum service temperature 450 degree F, moisture sorption less than 5.0% by weight, aluminum foil facing reinforced with fiberglass scrim laminated to UL rated Kraft paper. Composite 25/50-flame spread/smoke developed rating (ASTM E 84, UL 723, and NFPA 90A).

Secure with UL Listed pressure sensitive tape and/or outward clinched expanded staples and vapor barrier coating as needed.

Rigid Fiberglass Board (High Temperature): ASTM C 612, Type II, 3 lb/cu ft density, 0.23 "K" value at 75 degree F mean temperature, maximum service temperature 850 degree F, moisture sorption less than 5.0% by weight, 1-inch galvanized hexagonal wire mesh facing stitched on face of insulation. Composite 25/50-flame spread/smoke developed rating (ASTM E 84, UL 723, and NFPA 90A).

Secure with UL listed pressure sensitive tape and/or outward clinched expanded staples and vapor barrier coating as needed.

Flexible Fiberglass Blanket: ASTM C 553, Type II, 1.5 lb/cu ft density, 0.27 "K" value at 75 degree F mean temperature at compressed thickness, maximum service temperature 450 degree F, moisture sorption less than 0.2% by volume, aluminum foil facing reinforced with fiberglass scrim laminated to UL rated Kraft paper. Composite 25/50-flame spread/smoke developed rating (ASTM E 84, UL 40, and NFPA 90A).

Secure with UL listed pressure sensitive tape and/or outward clinched expanded staples and vapor barrier coating as needed.

Calcium Silicate: ASTM C 533, Type I, rigid molded block, noncombustible (ASTME E 136), 0.41 "K" value at 300 degree F mean temperature, maximum service temperature 1200 degree F, 160 psi compressive strength for 5 percent compression (ASTM C 165), flexural strength 70 psi (ASTM C 203). 0/0 flame spread/smoke developed rating (ASTM E 84).

Banded in place, tightly butted, joints staggered and secured with 16 gauge galvanized or stainless steel wire or 1/2-inch x 0.015-inch galvanized steel bands on 12-inch maximum centers for large areas.

Flexible Elastomeric Foam: ASTM C 534, Type II, flexible, cellular elastomeric sheet, 0.27 "K" value at 75 degree F mean temperature, maximum service temperature 220 degree F, water vapor permeability of 0.10 perm-inch, 25/50-flame spread/smoke developed rating (ASTM E 84, UL 723, and NFPA 255). Waterproof vapor retarder adhesive as needed. UV- protective coating for exterior applications: Foster 30-64 coating.

Jacketing Material for Equipment Insulation: Provide pre-sized glass cloth jacketing material, not less than 7.8 ounces per square yard, or metal jacket at Installer's option, except as otherwise indicated. Adhered with lagging adhesive/coating as specified.

Equipment Insulation Accessories: Provide staples, bands, wire, wire netting, tape, corner angles, anchors and stud pins as recommended by insulation manufacturer for applications indicated.

Equipment Insulation Coatings, Mastics, and Adhesives:

Vapor Barrier Coating (Store and apply between 40° F and 100° F, protect from freezing until dry): Used on below ambient piping/duct to prevent moisture ingress. Permeance shall be 0.013 perms or less at 43 mils dry per ASTM E 96, Procedure B.

Foster 30-80
Childers CP-38
Vimasco 749

Weather Barrier Mastic (Store and apply between 40° F and 100° F, protect from freezing until dry): Used on above ambient piping/duct outdoors.

Fosters 46-50
Childers CP-10/11
Vimasco WC-5

Lagging Adhesive/Coating (Store and apply between 40° F and 100° F, protect from freezing until dry): Comply with MIL-A-3316C, Class 1, Grade A.

Foster 30-36
Childers CP-50AHV2
Vimasco 713

Fiberglass Adhesive (Store and apply between 40° F and 100° F, protect from freezing until dry): Comply with ASTM C916, Type II.

Foster 85-60
Childers CP-127
Vimasco 795

Reinforcing Mesh: Used in conjunction with coatings and mastics.

Foster Mast a Fab
Childers Chil Glas #10
Vimasco Elast a Fab

PART 3 - EXECUTION

3.0 INSPECTION

Examine areas and conditions where mechanical insulation is to be installed. Do not proceed until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.1 HVAC PIPING INSULATION (Based 2015 IECC)

Editor's Note: Modify insulation thicknesses if the project is required to comply with ASHRAE 90.1.2010.

Refrigerant Piping:

Applications:

Suction

Insulation:

Flexible Elastomeric: 1 1/2-Inch thickness.

Cold Piping (40 Degree F (4 Degree C) to Ambient):

Applications:

Cooling coil condensate drain.

Insulation:

Fiberglass: 1-Inch thickness.

Low Temperature Cold Piping (40-60 Degrees F (4-15 Degrees C)).

Applications:

Chilled Water supply and return.

Insulation:

Fiberglass: 1-Inch thickness.

Hot Low Pressure Piping (141° F to 200° F (121 Degree C):

Applications:

Hot water supply and return.

Insulation:

Fiberglass: 1-1/2 Inch thickness up to 1 1/2" inch pipe, 2-inch thickness for all other pipe sizes.

Fiberglass for runouts up to 2-inch, 1-inch thickness.

3.2 DUCTWORK INSULATION

Flexible Fiberglass Blanket:

Concealed supply ductwork without liner: 1-1/2 Inch thickness. (IECC R5 min)
Return ductwork in unconditioned spaces without liner: 1-1/2 Inch thickness. (IECC R5 min)

Exhaust ductwork within 10 ft. of exterior opening without liner: 1-1/2 Inch thickness.
Unit housings that are not factory insulated: 1-1/2 Inch thickness.

Rigid Fiberglass Board:

Outside air ductwork and plenums: 1-1/2 Inch thickness.
Combustion air ductwork and plenums: 1-1/2 Inch thickness.
Mixed air ductwork and plenums: 1-1/2 Inch thickness.
Supply and return ducts exposed to the outdoors: 2-Inch thickness. (
Exhaust ducts between the air-handling unit and the exterior opening: 1-1/2 Inch thickness.

3.3 EQUIPMENT INSULATION

Cold Equipment (Below Ambient Temperature):

Applications:

Chiller cold surfaces not factory insulated.
Cold water storage tanks.
Chilled water pump impeller housings.
Expansion tanks.
Air separators.

Insulation:

Fiberglass Board: 1-1/2 Inch thickness.
Flexible Fiberglass Blanket: 1-1/2 Inch thickness.

Hot Equipment (Above Ambient Temperature):

Applications:

Boiler surfaces not factory insulated.
Hot water storage tanks.
Heat exchangers.

Insulation:

Fiberglass (High Temperature): 2-Inch thickness, except 3-inch thickness for low-pressure boilers and steam-jacketed heat exchangers. Do not use for equipment above 450 degree F (232 degree C).

Calcium Silicate: 2-Inch thickness, except 3-inch thickness for low-pressure boilers and steam-jacketed heat exchangers.

3.4 INSTALLATION OF PIPING INSULATION

Install insulation after piping system tests and heat trace installation have been completed.

Clean piping to remove foreign substances and moisture prior to applying insulation.

Install insulation products according to manufacturer's written instructions, building codes, and recognized industry standards.

Omit insulation on air chambers, unions, balance cocks, flow regulators, buried piping, and pre-insulated equipment.

Omit insulation on hot piping within radiation enclosures or unit cabinets; on cold piping within unit cabinets provided piping is located over drain pan; on heating piping beyond control valve, located within heated space; on condensate piping between steam trap and union; and on unions, flanges, strainers, flexible connections, and expansion joints.

Secure longitudinal jacket laps and butt strips according to manufacturer's recommendations.

Firmly rub lap and butt strips to pressurize seam and ensure positive closure.

Insulate each continuous run of piping with full-length units of insulation, with single cut piece to complete run. Do not use scraps.

Apply insulation to piping with all joints tightly fitted to eliminate voids.

Apply insulation on cold surfaces with a continuous, unbroken vapor seal. Hangers, supports, and anchors that are secured directly to cold surfaces must be adequately insulated and vapor sealed to prevent condensation. Seal pipe terminations in chilled water or glycol systems every four (4) pipe sections with vapor barrier coating.

Extend surface finishes to protect all surfaces, end, and raw edges of insulation.

Protect vapor-barrier jackets on pipe insulation from puncture or other damage. Avoid the use of staples on vapor barrier jackets. Seal vapor barrier penetrations with vapor barrier coating.

Cover valves, fittings and similar items with equivalent thickness and composition of insulation as applied to adjoining pipe run. Install factory molded or job fabricated covers (at Installer's option). Coat all below ambient valves, fittings and similar items with vapor barrier coating and reinforcing mesh before application of PVC covers.

Extend piping insulation without interruption through walls, floors and similar piping penetrations, except where fire-stopping materials are required.

Provide thermal shield inserts on all pipe (Refer to 230529). For piping below ambient temperature, apply vapor barrier lap cement on butt joints and seal with 3-inch wide vapor barrier tape.

Minimum insulation insert lengths:

1-1/2 – 2-1/2 Inch Pipe: 10-Inches
3 – 6-Inch Pipe: 12-Inches
8 – 10-Inch Pipe: 16-Inches
12-Inch and Larger Pipe: 22-Inches

Apply galvanized metal shields between hangers or supports and pipe insulation. Form shields to fit the insulation and extend up to the centerline of the pipe. The shield length shall be 4-inches less than the associated insulation hanger insert to allow for vapor retarding butt joints on each side of the shields.

Apply adhesives, mastics and coatings at manufacturer's recommended minimum coverage per gallon.

Replace all damaged insulation in whole; Repair of damaged insulation will not be accepted.

Insulate fittings and valves with PVC insulated fitting covers and insulation inserts per manufacturer's recommendations.

Install aluminum jacket on exterior piping.

Install metal jackets by overlapping seams 2-inches and securing with metal bands on 24-inch centers. Caulk all seams with 1/8” Bead of metal jacketing sealant. Locate longitudinal seams at the bottom of piping. Finish elbows and tees with matching metal fitting covers. Finish other fittings with conventional weather insulation materials with aluminum finish.

3.5 INSTALLATION OF DUCTWORK INSULATION

Install insulation products according to manufacturer's written instructions, building codes, and recognized industry standards.

Do not insulate fiberglass ductwork or lined ductwork.

Clean ductwork to remove foreign substances and moisture prior to applying insulation.

Apply insulation to ductwork with all joints tightly fitted to eliminate voids

Seal all vapor retardant jacket seams and penetrations with UL listed tapes or vapor retardant adhesive as recommended by the manufacturer. Coat all seams, breaks, tape patches and penetrations with vapor barrier coating.

Secure insulation to the underside of duct 24-inches or greater with mechanical fasteners or speed clips spaced 18-inches on center. Cut off protruding ends of fasteners after speed clips are installed and seal penetration of vapor barrier.

Extend ductwork insulation without interruption through walls, floors and similar penetrations, except where fire-stopping materials are required.

Install aluminum jacket on exterior ductwork insulation when not lined. Follow and comply with the jacketing manufacturer's installation guidelines.

Install corner angles on all external corners of insulation in exposed finished spaces before covering with jacketing.

Adhere flexible elastomeric sheets to ductwork by compression fit and full coverage of adhesive. Seal butt joints with same adhesive. Apply the same sheet thickness on standing metal duct seams as installed on the duct surface.

Jacket outdoor rigid insulation with Flexible Jacketing Membrane as specified. All longitudinal and circumferential seams must be overlapped a minimum of 3” (75mm). Ensure complete contact at the laps and to the substrate using a tape squeegee or roller applying firm pressure throughout. Install in strict accordance with manufacturer’s guidelines.

3.6 INSTALLATION OF EQUIPMENT INSULATION

Install insulation products according to manufacturer's instructions, building codes, and recognized industry standards.

Apply insulation as close as possible to equipment by grooving, scoring, and beveling insulation, if necessary. As required, secure insulation to equipment with studs, pins, clips, adhesive, wires, or bands

Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment use vapor retardant cement

Provide insulated dual temperature or cold equipment containing fluids below ambient temperature with vapor retardant jackets

Maintain integrity of vapor-barrier on equipment insulation and protect it to prevent puncture and other damage.

Do not apply insulation to equipment, mufflers, breechings, or stacks while hot.

Apply insulation using staggered joint method and double layer construction. Apply each layer of insulation separately.

Cover insulated surfaces with layer of insulating cement, troweled in workmanlike manner, leaving smooth continuous surface. Fill in scored block, seams, chipped edges and depressions, and cover over with wire netting and joints with 1/4-inch thick cement to remove surface irregularities.

Cover insulated surfaces with all-service jacketing neatly fitted and firmly secured. Lap seams at least 2-inch. Apply over vapor barrier where applicable.

Do not insulate manholes, handholes, cleanouts, ASME stamp, or manufacturer's nameplate. Provide neatly beveled edge at interruptions of insulation.

Provide removable insulation sections with aluminum jacket and stainless steel bands to cover parts of equipment which must be opened for maintenance; include metal vessel covers, fasteners, flanges, frames and accessories.

Provide aluminum jacketing on exterior insulated equipment as recommended by manufacturer.

END OF SECTION 23 07 00

SECTION 23 08 00

COMMISSIONING OF MECHANICAL SYSTEMS

PART 1 - GENERAL

1.0 SUMMARY

Section includes commissioning process requirements for HVAC&R systems, assemblies, and equipment.

The purpose of this Section is to define Contractor responsibilities in the commissioning process. Electrical equipment, component and system testing may be required under other Division 26 Specification Sections.

Commissioning requires the participation of the Contractor to ensure that all systems are operating in a manner consistent with the Contract Documents. General Commissioning requirements and coordination are detailed in Division 01. Division 23 Contractors shall be familiar with all parts of Division 01 and shall execute all Commissioning responsibilities assigned to them in the Contract Documents and include the cost of Commissioning in the Contract price.

1.1 DEFINITIONS

HVAC&R: Heating, Ventilating, Air Conditioning, and Refrigeration.

Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process. The Commissioning Plan is not a contractual document and summarizes the contractual and process requirements included in the contract documents.

CxA: Commissioning Authority.

Deferred Tests: Functional Performance or Integrated System Tests performed after Substantial Completion due to partial occupancy, partial equipment acceptance, seasonal requirements, design, or other site conditions that prohibit the test from being performed prior to Substantial Completion.

Pre-Testing: Functional Performance Testing occurring prior to system installations being substantially complete and the CxA receiving the Testing Prerequisite documentation. Typically, Pre-Testing efforts occur when Building Code or Authorities Having Jurisdiction require testing for the final electrical inspections or Certificate of Occupancy.

Start-up: The activities where equipment is initially energized, tested and operated. Start-up is completed prior to Functional Performance Tests.

Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

Test Requirements: Requirements specifying what systems, modes and functions, etc. must be tested. Test requirements are not detailed test procedures. Test requirements and acceptance criteria specified in the Contract Documents.

Test Prerequisites: Documentation and activities required to be completed by the Contractor(s) in advance of testing activities. Prerequisites include start-up, prefunctional checklists, product data cut-sheets and shop drawing submittals.

1.2 MECHANICAL EQUIPMENT AND SYSTEMS-TO-BE-COMMISSIONED

Building Automation System

HVAC System

1.3 DOCUMENT SUBMISSION REQUIREMENTS

Start-up Plan: The CxA shall witness start-up Contractor and Manufacturer activities. The Division 23 Contractor(s) responsible for start-up of any equipment shall develop a Start-Up Plan for equipment being commissioned. The primary role of the CxA in this process is to review the Start-up Plan(s) created by the Contractors, witness start-up of equipment and review the completed Start-up Plan(s) prior to Contractor, Manufacturer and functional performance testing associated with the Commissioning Process.

Organize and submit for review a binder of blank documents with sufficient detail, which upon project completion, will demonstrate the commissioned systems and equipment have been fully inspected and started in accordance with manufacturer's recommendations and standard industry procedures. At minimum this Plan must include major mechanical equipment:

Rooftop Units
Boilers
chillers
Fans
VFDs (Division 23 Contractors) to coordinate with Division 26 Contractors)

Submit the Start-up Plan to the CxA for review and comment prior to any Start-up activities commencing.

Updated Submittals: Keep the Commissioning Authority informed of all changes to control system documentation made during programming and setup; revise and resubmit when substantial changes are made.

HVAC Control System O&M Manual Requirements. In addition to documentation specified elsewhere, compile and organize, at a minimum, the following data on the control system. Provide electronic and hard copies per the requirements of this Section and the other applicable Specification Divisions.

Specific step-by-step instructions on how to perform and apply all functions, features, modes, etc. This documentation can be the Manufacturer's User or Instructional Manual, but must cover all the specific features of the as-built Installation and include an index and clear table of contents.
Include the detailed technical manual for programming and customizing control loops and algorithms.
Full as-built set of control drawings with equipment diagrams for each unique System, Subsystem, Equipment, and Component that interfaces with the temperature control system.
Full as-built sequence of operations for each unique System, Subsystem, Equipment, and Component.
Full points list; in addition to the information on the original points list submittal, include a listing of all rooms with the following information, where applicable, for each room:

Floor.
Room number.
Room name.
Air handler unit ID.
Reference drawing number.

Air terminal unit tag ID.
Heating and/or cooling valve tag ID.
Full print out of all schedules, set points and alarms after testing and acceptance of the system.

Schedules data shall, at a minimum, include the following and indicate the System, Subsystem, Equipment, and Component controlled by the schedule.

Occupied/unoccupied schedule
Holidays,
Special event
Timed override

Setpoint data shall, at a minimum, include:

As-built setpoints
Minimum and Maximums, where applicable. For example, DAT reset values.
Setpoint adjustability at Operator Interface and/or at User Interface (i.e. thermostat or temperature sensor)
PI&D controlled and parameters controlling loop

Alarm data shall, at a minimum, include:

Reset requirements
Alarm severity in accordance with the project's alarm hierarchy (i.e. critical, non-critical; or Level 1,2,3, etc.)
Indicate alarm as-built setpoints (i.e. value required to initiate alarm).
Indicate alarm type (i.e. analog or binary I/O)
Whether setpoint is adjustable at the BAS.
Whether setpoint is adjustable at specific piece of equipment or component.

Electronic copy on disk of the entire as-built software specific to this project.
Marking of all system sensors and thermostats on the as-built floor plan and HVAC drawings with their control system designations.
Maintenance instructions, including sensor calibration requirements and methods by sensor type, etc. Provide recommended schedule for sensor recalibration.
Control equipment component submittals, parts lists, etc.
Warranty requirements.
Copies of all checkout tests and calibrations performed by the Contractor (in addition to commissioning tests).
Organize and subdivide the manual with permanently labeled tabs for each of the following data in the given order:

Sequences of operation.
Control drawings.
Points lists.
Schedules.
Setpoints List.
Alarms List.
Controller and/or module data.
Thermostats and timers.
Sensors and DP switches.

Submit testing prerequisites to the CxA a minimum of 5 business days prior to the scheduled functional performance testing dates. Testing prerequisites include:

Testing, Adjusting and Balancing report. Provide written documentation that all deficiency items identified in the Testing, Adjusting and Balancing report have been addressed, or provide a schedule identifying when each item will be addressed. This shall include a schedule for when any additional testing, adjusting and balancing will be completed following corrective measures being completed.
Contractor Executed Prefunctional Checklists for each piece of equipment being commissioned.
72 hours of trend data for systems being commissioned in a format compatible with Microsoft Excel.
Building Automation System Point-to-Point Checkout documentation.

1.4 PROBLEM SOLVING

The CxA may recommend solutions to deficiencies identified during functional testing, startup and other commissioning activities.

The burden of responsibility to solve, correct and retest deficiencies is with the Contractors and the Design Team.

1.5 CONTRACTOR'S RESPONSIBILITIES

Perform commissioning tests at the direction of the CxA.

Attend commissioning meetings.

Provide information requested by the CxA for final commissioning documentation.

If the Contractor requires testing commence to facilitate code or contractual requirements and the CxA has not received the Testing Prerequisites and the system installations are not Substantially Complete, then time and expenses incurred by the CxA to complete any Pre-Testing shall be the responsibility of the Contractor.

1.6 CXA'S RESPONSIBILITIES

Provide prefunctional verification checklists and commissioning process test procedures for HVAC&R systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.

1.7 COMMISSIONING DOCUMENTATION

Upon request, the Contractors shall provide the following information to the CxA for inclusion in the commissioning plan:

Plan for delivery and review of submittals, and other documents and reports.
Process for completing Prefunctional Checklists and manufacturer's prestart and startup checklists for HVAC&R systems, assemblies, equipment, and components to be verified and tested.
Certificate of readiness, signed by the Contractor, certifying that HVAC&R systems, assemblies, equipment, components, and associated controls are ready for testing.
Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.
Test and inspection reports and certificates.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.0 PREPARATION

Construction Phase

In each purchase order or subcontract that is written for changes in scope, include the following requirements for submittal data, Commissioning documentation, testing assistance, Operating and Maintenance (O&M) data, and training, as a minimum.
Provide manufacturer's data sheets and shop drawing submittals of equipment.
Provide additional requested documentation to the Contractor, prior to O&M manual submittals, for development of Prefunctional Checklist and Functional Performance Tests procedures.

Typically, this will include detailed manufacturer's installation and Start-up, operating, troubleshooting and maintenance procedures, full details of any Owner-contracted tests, full factory testing reports, if any, and full warranty information, including all responsibilities of the Owner to keep the warranty in force clearly identified.

This information and data request may be made prior to normal submittals.

Submit manufacturer's detailed Start-up procedures and other requested equipment documentation to CxA for review.
During the Start-up and initial checkout process, execute and document related portions of the Prefunctional Checklists for all commissioned equipment.
Address current A/E and Owner punch list items before Functional Performance Tests.
Provide skilled technicians, familiar with the project and equipment, to execute start-up of equipment and to assist in execution of Functional Performance Tests. Ensure that they are available and present during the agreed-upon schedules and for a sufficient duration to complete the necessary tests, adjustments, and problem solving.
Correct deficiencies (differences between specified and observed performance) as interpreted by the CxA, Owner and A/E and retest the system and equipment.
Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.
Certify that Mechanical systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.
Inspect and verify the position of each device and interlock identified on Prefunctional Checklists.
Execute Start-Up Plan

Two weeks prior to each startup, the Division 23 Contractors shall confirm the scheduled start-up with the Owner, A/E and CxA. .

The CxA and possibly the A/E will observe the procedures and tests for selected pieces of primary equipment. It is the intent the CxA will observe the tests during contractor testing. If the contractor does not inform the CxA of testing, the CxA may request the contractor to repeat the test.
The CxA will observe the physical start-up of select major systems.
The Subs and vendors shall execute startup and update the Start-Up Plan with a signed and dated copy of the completed start-up checklists. The Construction Manager reviews for completion and accuracy, then submits to the CxA.
Only individuals that have direct knowledge and witnessed that a line item task on the checklist was actually performed shall initial or check that item off. It is not acceptable for witnessing supervisors to fill out these forms.

Completed startup test reports must be provided to CxA prior to functional testing.

Warranty Phase

If any check or test cannot be completed prior to Substantial Completion due to the building structure, required occupancy condition, or other condition, execution of such test may be delayed to later in the Warranty Period, upon approval of the Owner. Contractor shall reschedule and conduct these unforeseen deferred tests in the same manner as deferred tests.

Contractor shall correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.

3.1 TESTING, ADJUSTING AND BALANCING VERIFICATION

Notify the CxA at least 10 business days in advance of testing and balancing Work, and provide access for the CxA to witness testing and balancing Work.

If any portion of this specification section contradicts or duplicates requirements found elsewhere in the Contract Documents, the more stringent requirements shall apply.

3.2 GENERAL TESTING REQUIREMENTS

Testing will not be initiated until the testing prerequisites have been completed. The CxA must receive documentation indicating the testing prerequisites are fully complete a minimum of 5 business days prior to commencement of the functional performance testing. Any testing executed prior to the receipt of the testing prerequisites may be determined by the CxA as Pre-Testing.

Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.

Scope of HVAC&R testing shall include entire HVAC&R installation, from central equipment for heat generation and refrigeration through distribution systems to each conditioned space. Testing shall include measuring capacities and effectiveness of operational and control functions.

Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.

The CxA along with the HVAC&R Contractor, testing and balancing Contractor, and HVAC&R Instrumentation and Control Contractor shall prepare detailed testing plans, procedures, and checklists for HVAC&R systems, subsystems, and equipment.

Tests will be performed using design conditions whenever possible.

Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.

The CxA may direct that set points be altered when simulating conditions is not practical.

The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.

If tests cannot be completed because of a deficiency outside the scope of the HVAC&R system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.

If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.3 CONTROL SYSTEM TESTING PROCEDURES

Prefunctional Checklists for control system components will require a signed and dated certification that all system programming is complete as required to accomplish the requirements of the Contract documents and the detailed Sequences of Operation documentation submittal.

Do not start Functional Testing until all controlled components have themselves been successfully Functionally Tested in accordance with the Contract Documents.

Using a skilled technician who is familiar with this building, execute the Functional Performance Testing of the control system as required by the Commissioning Authority.

Functional Performance Testing of the control system constitutes demonstration and trend logging of control points monitored by the control system.

Perform all trend logging specified in Prefunctional Checklists and Functional Test procedures, and trend up to 50 percent more points than specified at no extra cost to the Owner or Project.
The Contractor shall submit trend logs to the CxA in a comma separated value (csv) or other approved format. The data must be arranged such that variables are aligned with each time stamp.

Functionally Test integral or stand-alone controls in conjunction with the Functional Performance Tests of the equipment they are attached to, including any interlocks with other equipment or systems; further testing during control system Functional Performance Test is not required unless specifically indicated below.

Demonstrate the following to the Commissioning Authority during testing of controlled equipment; coordinate with commissioning of equipment.

Setpoint changing features and functions.
Sensor calibrations.

Demonstrate to the Commissioning Authority:

That all specified functions and features are set up, debugged and fully operable.
That scheduling features are fully functional and setup, including holidays.
That all graphic screens and value readouts are completed.
Correct date and time setting in central computer.
Power failure and battery backup and power-up restart functions.
Global commands features.
Security and access codes.
Remote alarm notifications.
Occupant over-rides (manual, telephone, key, keypad, etc.).
O&M schedules and alarms.
Occupancy sensors and controls.
If the control system, integral control components, or related equipment do not respond to changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice, under any of the conditions, sequences, or modes tested, correct all systems, equipment, components, and software required at no additional cost to the Owner or Project.

3.4 OCCUPANCY AND WARRANTY PHASE COMMISSIONING

The Contractor and CxA will complete seasonal Functional Performance Testing in accordance with the Cx Plan and the above requirements of this specification section. In general, the season functional performance testing will require reconvening the project team to test system performance during the opposite season from the original functional performance testing (e.g. cooling system testing if systems were originally tested during winter or heating systems testing if systems originally tested during summer).

The Contractor will document a plan, if required, for resolution or correction of outstanding commissioning issues. The plan will identify each issue separately, with an agreed upon resolution; deadline for implementation of corrective measures; party or parties responsible for corrective measures and any criteria required for owner acceptance of the corrective measure.

The Temperature Controls Contractor shall assist the CxA and Owner in troubleshooting, tuning, optimization and/or Owner Training for up to an additional 24 hours beyond all other labor requirements indicated in the Contract Documents. If unused, these hours shall expire at the end of the warranty period.

END OF SECTION 23 08 00

SECTION 23 09 00

DIRECT DIGITAL CONTROL SYSTEM

PART 1 - GENERAL

1.0 DESCRIPTION OF WORK

Provide a direct-digital control (DDC) system per the project documents, point list, interoperability tables, drawings and specifications. Include all engineering, programming, controls and installation materials, installation labor, commissioning, start-up, training, final project documentation and warranty.

The DDC system shall consist of high-speed BACnet IP, peer-to-peer network of DDC controllers, a dedicated server, a Personal Computer Operator Workstation (OWS) and printer. Provide remote access using a standard client server web browser to access the control system graphics, parameters and change adjustable set points with password protection.

The direct-digital control system shall be native BACnet. All new workstations, controllers, devices and components shall be listed by BACnet Testing Laboratories (BTL) with accessibility using a Web browser interface, and shall communicate exclusively using the ASHRAE Standard 135 BACnet communications protocol without the use of gateways, unless otherwise allowed by this Section of the technical specifications and specifically shown on the design drawings.

If used, gateways shall support the ASHRAE Standard 135 BACnet communications protocol.

The work administered by this Section of the technical specifications shall include all labor, materials, special tools, equipment, enclosures, power supplies, software, software licenses, project specific software configurations and database entries, interfaces, wiring, tubing, installation, labeling, engineering, calibration, documentation, submittals, testing, verification, commissioning, training services, permits and licenses, transportation, shipping, handling, administration, supervision, management, insurance, warranty, specified services and items required for complete and fully functional controls systems.

The control systems shall be designed such that each mechanical system shall operate under stand-alone mode. The contractor administered by this Section of the technical specifications shall provide controllers for each mechanical system. In the event of a network communication failure, or the loss of any field controller, the control system shall continue to operate independently. Failure of the operator workstation(s) (OWS) shall have no effect on the field controllers, including those involved with global strategies.

The control system shall accommodate no less than two (2) operator workstations, the control system shall also accommodate web-based users simultaneously, and access to the system should be limited only by operator password.

The control system will provide for future expansion to include monitoring of card access, fire alarm, energy management and lighting control systems.

The Contractor shall become aware of the Commissioning requirements outlined in Specification Section 23 08 00. Change orders shall not be considered for time associated with these requirements.

General: The Control System Contractor shall provide a complete new control system using new control devices to operate as specified.

The Control System for this project will be referred to as a Building Automation System (BAS).

Total quantity and type of control points shall consist of specifications, drawings and as required to complete the Sequence of Operation as specified. Additional points shall be provided as required to meet all operational functions, safeties, monitoring and reporting requirements. The Drawings and Specifications are not intended to show all details necessary to make the system complete and operable.

The BAS shall include all control devices, valves, interlocks, field devices, hardware, software, automatic dampers, piping, fittings, wire, conduit, etc., as specified, required and connected so as to perform all functions and operate according to the specified sequences.

This installation shall not be used as a test site for any new products unless explicitly approved by the Owner or Engineer in writing. Unless approved otherwise, all products (including firmware revisions) used in this installation shall have been used in at least twelve (12) projects prior to this installation. The previous sites may be located anywhere in the U.S.A. This requirement is not intended to restrict the Contractor to the use of any outdated equipment. Therefore, all products used in this installation shall also be currently under manufacture and have available, for at least ten (10) years after completion of the contract, including spare parts, board repairs and software revisions. If the above requirements are mutually exclusive, the Contractor shall include a specific statement to this effect in the Bid.

Refer to other Division 23 sections for installation of instrument wells, valve bodies and dampers in mechanical systems.

Provide electrical work as required, complying with requirements of Division 26 sections including, but not limited to raceways, wires, cables, electrical identification, supporting devices and electrical connections for equipment. Work includes, but is not limited to, the following:

Interlock and control wiring between field-installed controls, indicating devices and unit control panels.
The Contractor shall be responsible for all additional electrical and other costs involved to accommodate the temperature control system panel, motors and electrical devices requiring power which differs from the power requirements shown on the Electrical Drawings.

1.1 QUALITY ASSURANCE

Contractor’s Qualifications: Firms regularly engaged in installation, commissioning and servicing of digital control equipment, of types and sizes required, whose firm has been in business in similar service for not less than five (5) years. Contractor shall have an established working relationship with the Control System Manufacturer of not less than three (3) years.

Only those Contractors who are certified to install DDC systems from specified manufacturers are allowed to bid temperature controls. All bidders shall make available, upon the Owner's request, open book unit pricing of all materials and labor.

The system shall be installed by competent mechanics, regularly employed by the Temperature Control Contractor.

No Field Devices shall be multiplexed to a single I/O point unless specified. Each device or sensing point shall be terminated at a unique location on the Control Panel, Dedicated Controller or Slave and be associated with a unique software point on the BAS.

Codes and Standards:

All equipment and the installation shall comply with the requirements of all applicable local and national codes including but not limited to the currently enforced edition of the International Building Code, Fire Code, Electrical Code, and all applicable codes of the National Fire Protection Association including the National Electrical Code.

Electrical Standards: Provide electrical products which have been tested, listed and labeled by UL and comply with NEMA Standards.
NEMA Compliance: Comply with NEMA standards pertaining to components and devices for electric control systems.
NFPA Compliance: Comply with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems" where applicable to controls and control sequences.

The Temperature Control Contractor shall cooperate with other contractors performing work on this project necessary to achieve a complete and neat installation. To that end, each contractor shall consult the drawings and specifications for all trades to determine the nature and extent of others work.

It will be the responsibility of the Contractor to work in cooperation with the Owner and with all other contractors and employees rendering such assistance and so arrange his work such that the entire project will be delivered complete in the best possible condition and in the shortest time.

1.2 PROPRIETARY INFORMATION

Project Documentation: All custom software, passwords, programs, code, databases, graphic files and drawings (whether hard copy or electronic files) prepared for this system shall be the exclusive property of the Owner and shall not be reproduced or distributed without prior written permission from the Owner.

1.3 SUBMITTALS

Submit in accordance with Division 1 and 23 submittal requirements.

In addition to the requirements set forth in Paragraph A above, the following shall be included in the shop drawing submittals including, but not limited to:

Product Data: Submit manufacturer's technical product data sheets for each control device furnished, each data sheet shall be labeled indicating its' control drawing descriptor. When manufacturers data sheets apply to a product series rather than a specific product, the data that is specifically applicable to the project shall be highlighted or clearly indicated by other means. Submittals shall include the following:

Indicating dimensions;
Capacities;
Performance characteristics;
Electrical characteristics;
Finishes of materials;
Installation, start-up, test and verification instructions.

Control system drawings containing pertinent data to provide a functional operating system and a sequence of operation.
Detailed wiring diagrams.
Schematic flow diagram of system showing fans, pumps, coils, dampers, valves, and all control devices. Identify all control points with labeling.
Indicate for each control device a set point or adjustable range of control. Provide a bill of materials with manufacturer's part number.
Indicate all required point-to-point electrical wiring.
Provide details of faces of control panels, including controls, instruments, and labeling.
Include verbal description of sequence of operation and reference each device described by schematic symbol used.

Provide a point list with database input information to include a point name, address, base and span, action and other required information.
Provide a detailed test plan and procedure for each HVAC system and for each type of terminal unit control including valves. The test plans shall fully define reporting methods, procedure, equipment utilized, milestones for the tests, identifying the simulation programs, and personnel. The test procedures shall be developed from the test plans and shall consist of instructions for test execution and evaluation. A test report form shall be developed for each point and sequence of operation. Commissioning procedures shall be provided for each HVAC system and for each type of terminal unit control system. The procedure shall include set point, prop. band, integral, derivative, mode constraints input, output settings, tuning procedures., etc.

Submit manufacturer's installation instructions.

Submittal Data and Shop Drawings shall be prepared and submitted in the following formats:

All drawings prepared for the project shall be developed using the AutoCad CADD program Rev. 14.0 or most current version, (or a CADD package capable of producing AutoCad "DXF" compatible format files).
All submittals data shall be the same size for any group of information and shall be in a three (3) screw and post binder. (NO EXCEPTIONS). All the information shall be indexed and tabbed with reference to the specific section of these specifications.
The format for different groups of submittal information are as follows:

Control drawings, building plans (including complete floor plans), schematics and system configurations shall be CADD prepared drawing, bound and indexed. Drawings that cannot represent the total information on an individual ANSI size B (11" x 17") drawing, i.e., a building plan, shall be noted with appropriate match lines, cross references and key plans.
Technical data, sequence of operations, material list, point lists, program listings, I/O schedules, operator's and programmer's manuals, etc., shall be type written, original product data sheets or CADD prepared drawings, ANSI Size A or ANSI Size B.

Upon completion of the project and acceptance of systems, the Contractor shall provide to the Owner two (2) hard copies and one (1) electronic copy of Record (As-Built) Shop Drawings.

Shop drawings shall include riser diagram depicting locations of all controllers and workstations, with associated network wiring. Also included shall be individual schematics of each mechanical system showing all connected points with reference to their associated controller, written operational sequences and testing and commissioning reports and checklists.

Shop Drawings shall be submitted for approval prior to beginning work. When the Architect/Engineer requires, the Contractor will resubmit with the corrected or additional submittal data. This procedure shall be repeated until all corrections are made to the satisfaction of the Engineer and the submittals are fully reviewed.

Contractor agrees that shop drawing submittals processed by the Architect/Engineer are not change orders, that the purpose of shop drawing submittals by the Contractor is to demonstrate to the Architect/Engineer that the Contractor understands the design concept, that he demonstrates his understanding by indicating which equipment and material he intends to furnish and install, and by detailing the fabrication and installation methods he intends to use. The Contractor shall be responsible for space requirements, configuration, performance, changes in bases, supports, structural members and openings in structure, and other apparatus that may be affected by their use.

Contractor further agrees that if deviations, discrepancies, or conflicts between shop drawing submittals and the contract documents in the form of design drawings and specifications are discovered either prior to or after shop drawing submittals are processed by the Architect/Engineer, the design drawings and specifications shall control and shall be followed. If alternates do not meet these requirements, it shall be this Contractor's responsibility to remove them and install material originally specified, at no cost to the Owner.

1.4 DELIVERY, STORAGE AND HANDLING

Provide factory shipping cartons for each piece of equipment, and control device. Maintain cartons through shipping, storage and handling as required to prevent any equipment damage, and to eliminate all dirt and moisture from equipment. Store all equipment and materials inside and protected from weather.

PART 2 - PRODUCTS

2.0 ACCEPTABLE MANUFACTURERS

Subject to compliance with requirements, install a direct digital control system from one (1) of the following manufacturers / system integrators:

TRANE SC

All BAS components shall be by one of the above manufacturers, except when “controls provided with the unit,” “factory-mounted controls,” “unit manufacturer provided controls,” etc, are referenced by this specification, “BAS Components” includes BAS Panels/Routers/controllers, and operator interface, color-graphics interface, control and programming software. Valves, actuators, sensors, conventional thermostats and other stand-alone controls and other field devices need not be by the same manufacturer.

2.1 GENERAL PRODUCTS DESCRIPTION

The Building Automation System (BAS) shall be capable of integrating multiple building functions including equipment supervision and control, alarm management, energy management, historical data collection and archiving, maintenance support, custom processes and manual override monitoring. All products and materials installed shall be suitable for the intended application requirements including but not limited to:

Accuracy
Rangeability
Temperature and pressure ranges
Shutoff pressures
Differential pressures
Repeatability
Materials of construction suitable with the environment and/or media in which they are in contact with
Code compliance
Velocities

The BAS shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, controllers, and operator devices. The system architecture shall support a minimum spare capacity of 20% for all types of DDC devices and all point types included in the initial installation. The BAS shall consist of the following:

BACnetIP Architecture
Operator Workstation
Portable Operators Workstation

Building Controllers
Application Specific Controllers
Point Expansion Modules
Building Routers
Auxiliary Control Devices
Valves
Dampers
Actuators
Power Supplies and Line Filtering
Wiring and Raceways
Sensors/Transmitters

BAS architecture shall eliminate dependence upon any single device for alarm reporting and control execution. Each DDC controller shall operate independently by performing its' own specified control, alarm management, operator I/O, and historical data collection. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.

Each DDC controller shall continue to execute its control software, sample input points, and update output points without connection to the DDC panel network, Controller network or an operator interface.

All DDC controllers shall be able to access data from, or send control commands and alarm reports directly to, any other DDC controller or combination of controllers on the network without dependence upon a central processing device. All DDC controllers shall also be able to send alarm reports to multiple operator workstations without dependence upon a central processing device.

The BAS shall allow third party software to operate on a personal computer operator workstation without any degradation to the controls operating normally.

Remote Communications: The BAS shall be remotely accessible via an Internet connection provided by others. Inherent in the system's design shall be the ability to expand or modify the network via the local area network, or auto-dial telephone line modem connections, or via a combination of the two (2) networking schemes.

All DDC controllers and application-specific controllers shall be connected to DDC routers via "Controller Network(s)" (BACnet MS/TP). A sufficient number of DDC routers shall be provided to support the number of controllers and application-specific controllers required.

A sufficient number of DDC routers/panels/controllers shall be provided to meet the memory needs of the BAS programming, alarming and trending (24 samples for each point alone, not including that needed for Measurement and Verification (M&V) along with 25% spare capacity for future use.

A sufficient number of DDC routers/panels/controllers and application-specific controllers (here after referred to in general as "DDC device(s)") and point expansion modules shall be provided to meet the point needs of the project. Point termination types shall include:

Analog Input (AI) – Thermistor, 0-10 VDC or 4-20 mADC
Binary Input (BI) – Monitoring of dry contacts, including contact closure "pulses" up to 10 per second.
Analog Output (AO) – 0-10 VDC, 0-20 VDC or 4-20 mADC
Binary Output (BO) – Two state DC voltage signal or magnetically held dry contact closure.

An application-specific controller shall not be used for systems/equipment that require custom application programming to meet the Sequence of Operation (i.e., if an application-specific controller is used, the factory-provided control software and program must be able to perform the Sequence of Operation without “upper level” control from a DDC panel, etc.).

Digital Communications to Third-party Controls

The BAS is required to send/receive information via digital communication technologies (e.g. Ethernet/IP, EIA-485); application protocols (e.g., BACnet, Modbus) to specified Third-Party controls provided under this or other sections of the specification (e.g. chillers, VFDs, BTU meters, electrical submeters, lighting controls, etc.).
See the Specification sections of the equipment involved, for the type of communications technology/interface (e.g. the data link layer protocol), and application protocol used by each of the Third-Party controls, and for the list of data to be shared with these controls.
Communications not requiring a gateway (i.e., BACnet): Design the BAS to include the DDC device models (with optional modules if necessary) that provide the necessary data link layer interfaces.

Hardware Override Monitoring: The BAS shall monitor the status or position of all overrides, and include this information in logs and summaries to inform the operator that automatic control has been inhibited. The BAS shall also collect override activity information for daily and monthly reports.

Power Fail Restart: In the event of the loss of normal power, there shall be an orderly shutdown of all standalone DDC panels to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data, and battery back-up shall be provided to support the real-time clock and all volatile memory for a minimum of seventy-two (72) hours.

Upon restoration of normal power, the DDC panel shall automatically resume full operation without manual intervention.
Should DDC panel memory be lost for any reason, the user shall have the capability of reloading the DDC panel via the local area network and Internet connection.

2.2 OPERATOR WORKSTATION

Operator Interface Software – The software shall include the following capabilities:

Graphic screens display of custom graphic screens with dynamic point information and the ability to show animation by shifting image properties based on the status of the point.

The terms “graphic screens” and “graphic(s)” in this specification refers to graphical images viewed via a PC running operator interface software or a PC viewing graphical images on web pages via a web browser.
Graphic Generation: Graphic files shall be created with the use of a graphics generation package furnished with the system. The graphics generation package shall also provide the capability of capturing or converting graphics from other programs such as (AutoCAD) (Revit).
Graphics Library: Furnish a library of standard HVAC system/equipment graphics screens such as chillers, boilers, air handlers, terminals, fan coils, unit ventilators, etc.; and standard symbols for HVAC components including fans, pumps, coils valves, piping, dampers, ductwork, etc.

System Applications – Provide the following:

System Databases Save and Restore: Automatic (when changes occur) and/or manual backup of the system database (e.g., a DDC panel point database and/or control program). The operator shall also be able to manually initiate a download of a specified database to any DDC device in the BAS.
System Configuration: Provide application for BAS configuration (DDC device communications addressing, point definition, etc.).
Help: Provide a context sensitive help system to assist the operator in operation of the BAS.
Security: Each operator shall be required to log on to the BAS with a unique name and password in order to view edit, or delete data. System security level shall be configurable for each operator via the site administrator login.
System Diagnostics: the System shall automatically monitor the operation of all DDC devices including network communications and provide an alarm when a failure occurs.

Standard BAS Operating Features:

Point/Data Overrides/Modifications: Output points and system data (i.e., set points) shall be modifiable (i.e., auto vs. manual and overridden value) via a link to each item's graphic screen image.
Alarm Processing: An alarm log with acknowledgement and alarm clearing functions, the ability to configure alarm limits, and system reactions (e.g., an alarm message, communications method, etc.).
Alarm Logs: The ability to define a custom historical trend log for any data in the system. The data can be displayed tabular or graphical.
Scheduling: A graphical method for scheduling equipment operation including normal, holiday and exception scheduling.
Utilize real time 3-D graphics for building control and visualization.
The system is to utilize a Windows based object-oriented navigation system.
System must be capable of paging, printing, texting and emailing alarm notifications.
System must be able to analyze/display no fewer than eight trend logs in a real-time graph.

Control Software Editors: The software shall allow for Operator editing of all control applications including the following:

Application Specific Controller: A full screen graphical editor for each type of application that allows the operator to view and change the configuration, name control parameters, and set points for all controllers.
Custom Control Programming: A graphic for creating, modifying, and debugging the custom control programming for all routers/panels controllers.
Graphic Design Software: Software for generating new real-time 3-D graphics for use in the operator workstation.

Web Server: This shall, as a minimum allow PC's running web browser software to perform all the capabilities described above except Graphic Generation, System Database and Restore, System Configuration, and Control Software Editors.

The software shall support an unlimited amount of client users.
Point/Data Overrides/Modifications: Output points and system data (i.e., set points) shall be modifiable (i.e., auto vs. manual and overridden value) via a link to each item's graphic screen image.
Alarm Processing: An alarm log with acknowledgement and alarm clearing functions: and the ability to configure alarm limits, and system reactions (e.g., an alarm message, communications method, etc.).

Trend Logs: The ability to define a custom historical trend log for any data in the system. The time stamp data can be displayed tabular or graphical.
Scheduling: a graphical method for scheduling equipment operation including normal, holiday and exception scheduling.
Utilize real time 3-D graphics for building control and visualization.
The system is to utilize a Windows based object-oriented navigation system.
The system shall allow tenant access to view and adjust local set point as well as view equipment in their space.
System must be capable of paging, printing and emailing alarm notifications.
System must analyze no fewer than eight trend logs in a real-time graph.

Historical Data Management: Record extended periods of data from the DDC system which shall be integrated and viewable within the operator workstation. The historical system should automatically restart following a power failure and will automatically determine the optimal time to back up data from the controllers to minimize data loss. The data should be stored in a SQL database to allow for access from third-party tools.
Other Requirements:

Third-Party Software: Provide any other software needed for the operation of the operator interface software, such as Microsoft SQL or .NET, .AWN, Excel, etc.

Hardware – Provide the following:

General: The specifications for the equipment below shall be the minimum provided. Expanded hardware capabilities (e.g., faster processor, larger hard drive, etc.) shall be provided based on the BAS manufacturer's operator interface requirements and which are needed to meet the BAS needs for data storage including that for M&V (along with 25% spare capacity).

Operator WorkStation and Web Server

Operator Workstation PC: Microsoft Windows-based desktop PC including Windows Professional operating system, MS Internet Explorer 8, MS Excel 2007, Intel I7 series processor with 2.5GHz speed minimum, 4GB RAM, 256 MB graphics card, one 16x CD/DVD +/-RW drive, 7200 rpm dual RAID 1TB hard disk drive, 10/100/1000 MHz Ethernet card, a 19" LCD color flatscreen monitor, PS/2 standard keyboard, two button optical mouse and a laser printer with cable.

Uninterruptable Power Supply (UPS) – For backup power to all Operator Workstation Components: APC Smart 750VA USB and serial 120 VAC, APC art #SUA750, or equivalent.
All operator interface software functions listed above (except the Web Server) shall be accessible from this PC (as a Client to the Web Server and/or with the operator interface software installed on this PC).
A separate PC shall be provided if the operator interface software architecture does not allow the Web Server software capability to be operated on the same PC as that required for the other operator Interface software capabilities.

Portable Operator's Terminal: MS Windows-based notebook-style PC including RAM memory of sufficient capacity to meet the requirements of the operator interface software, color screen (but not 10"), one CD/DVD drive , one 1000 GB minimum hard disk, integral pointing device, and an Ethernet port. This terminal shall be configured for interface with any DDC device in the BAS: furnish all required serial and/or network communication ports, and all cables for proper BAS operation.

Number of PCs Supported: The operator interface software provided for the above hardware (except for the Web Server capability) shall be fully functional for two (2) simultaneous PCs (i.e., so that the software can be used simultaneously on both the Workstation and Portable PCs).

2.3 BUILDING CONTROLLERS

Building Controller is BTL-listed BACnet B-BC device as defined below with non-volatile memory for operating system software; 72-hour battery-backed read/write memory for custom programming; communications support for operator interface and the Controller Network.

Building Controller Network- Provide 76.8kps BACnet MS/TP communications (as a master).

Point Termination-building controllers shall provide direct point termination through integral point connections, point expansion and/or point expansion modules.

Point expansion shall communicate with the Building Control Panel via the Panel's microprocessor bus (i.e., they shall not use EIA-232/485 and/or any type of LAN technology like MS/TP).
A "point Expansion Module" as defined below shall be installed within the same enclosure as the associated Building Control Panel.

2.4 APPLICATION SPECIFIC CONTROLLERS

An application Specific Controller is a BTL- listed BACnet B-AAC or B-ASC device dedicated for use with specific equipment and applications. It shall be provided with the no volatile memory for operating system software; read/write memory for all other purposes; factory-provided control software; and communications support for operator Interface, and the Controller network.

Application Specific Controllers shall only be used for terminal/zone equipment such as VAV terminal units, constant-volume terminal units, fan coil units, and heat pumps (i.e., when the factory-provided control software meets the Sequence of Operation) or where explicitly allowed by the Sequence of Operation.

ASC's for pressure-independent VAV-terminal-unit control shall have an integral differential pressure sensor for air flow measurement and an optionally integral damper actuator.

Each ASC shall have a 76.8Kbps BAC net MS/TP Controller Network connection (as an MS/TP Master).

2.5 APPLICATION CONTROLLERS

A DDC panel is a BTL-listed BACnet B-BC or B-AAC device with the BACnet options specified below, non-volatile memory for operating system software: 72-hour battery-backed read/write memory for custom control programming, trending, and alarming; real time clock; integral point or point expansion terminations; and communications support to other DDC routers/panels.

DDC Router/panel Network: Provide 100baseT Ethernet minimum communications with BACnet/IP support for interconnection to other DDC routers/panels, operator interfaces, and to an Internet/intranet connection, if specified.

Point Termination-DDC panels shall provide direct point termination through integral point connections, point expansion and/or point expansion modules.

Point expansion shall communicate with the DDC panel via the Panel's microprocessor bus (i.e., they shall not use EIA-232/485 and/or any type of LAN technology like MS/TP). A "point Expansion Module" as defined below shall be installed within the same enclosure as the associated DDC panel.

2.6 POINT EXPANSION MODULE

A point expansion module provides slaved control (i.e., it does not execute its own control software) via a serial or multi-drop communications connection (e.g., EIA-485, MS/TP, etc.) from a DDC device.

A point expansion module cannot be used as a DDC router/panel/controller or Application specific Controller, and shall be mounted within the same enclosure as the DDC router/panel/controller is serves.

2.7 BUILDING ROUTER

A Building Panel is BTL-listed BACnet B-BC or B-AAC device with the BACnet options specified below, non-volatile memory for operating system software; 72-hour battery-backed read/write memory for custom control programming, trending, and alarming; real time clock; integral point or expansion terminations; and communications support to other DDC routers/panels.

Building Router/Panel Network: Provide 100base T Ethernet minimum communications using the BACnet/IP data link layer for interconnection to other DDC routers/panels, operator interfaces, and to an Internet/Intranet connection, if specified.

Routing: Provide BACnet Clause 6 Routing (between the specified DDC router and controller network technologies) and BAC/IP Broadcast Management (BBMD).

Controller Network: A building router shall be a Master to one or more 76.8kps BACnet MS/TP data link layer communications connections for DDC controllers and application-specific controllers.

Point Termination- Building routers may not be utilized for direct point termination through integral point connections, point expansion and/or point expansion modules.

2.8 AUXILIARY CONTROL DEVICES – ELECTRONIC

Control relays: Plug-in type with dust cover and LED "energized" indicator. Contact rating, configuration, and coil voltage suitable for the application.

Low-Temperature Detection Switches (Freezetats): Provide DPDT low temperature-protection thermostats of manual-reset type, with sensing elements of the proper length, but in no case less than 20'-0" in length. Provide thermostat designed to operate in response to coldest 1'-0" length of sensing element, regardless of temperature at other parts of element. Support element properly to cover entire duct width. Provide separate thermostats for each on 25 sf of coil face area or fraction thereof. The set point shall be 42° F unless otherwise specified on the plans or sequence of operations.

Current Sensing Switches: Use for all motor-status BI point unless otherwise noted; shall be self-powered, solid-state with adjustable trip current. The switch shall be selected to match the current of the application and input requirements of the BAS.

Differential Pressure Switches: Used only for duct pressure safety cut–offs unless otherwise noted. Adjustable trip pressure with range suitable for the application.

On–Off thermostats: Provide thermostats of bi-metal actuated open contact, bellows-actuated enclosed snap-switch type, or equivalent. Provide solid-state type with electrical rating to meet the application. Provide with surface mounted ventilated enclosure.

Provide duct smoke detectors in HVAC ducts in accordance with NFPA 72 and NFPA 90A, except as indicated otherwise. Provide UL listed or FM approved detectors, designed specifically for duct installation. Smoke detectors are to be double pole/double throw to allow for simultaneous fan shut off and fire alarm detection. Refer to M&E coordination specification section for more details.

2.9 VALVES

Control Valves: Provide factory fabricated control valves of appropriate pressure class for the scheduled service. Provide size-modulating valves for a pressure drop of 3 to 5 PSI for water service, unless otherwise noted. Two-position valves shall be line size.

Water Service Values: Equal percentage characteristics with range ability of 50 to 1, and maximum full flow pressure drop of 5 psig.
Single Seated Valves: Cage type trim, providing seating and guiding surfaces for plug on “top and bottom” guided plugs.
Double Seated Valves: Balanced plug type, with cage trim providing seating and guiding surfaces on “top and bottom” guided plugs.
Valve Trim and Stems: Polished stainless steel.
Packing: Spring-loaded Teflon, self-adjusting.
Terminal Unit Control Valves: Provide control valves for control of terminal units including, but not necessarily limited to, convectors, finned tube radiation, and fan-coil units that are of integral motor type. Provide 2–position or modulating type valves. Select valves to fail safe in normally open or closed position as dictated by freeze, humidity, fire or temperature protection.
Valves: 1/2” through 2”: Valves shall be constructed with a cast-brass body and screwed ends. For 1-1/2” and 2” special duty, valves may be selected by the control manufacturer to have either bronze or cast iron bodies with screwed or flanged connections.
Valves: 2 1/2” and above: Valves shall be constructed with a cast-iron body and have flanged connections.
Butterfly Valves: high performance valves with stainless steel disc and PTFE steel ring shall be used. Body shall be carbon-steel body, 150 lb full ANSI rated bi-directional, lug style butterfly type, bi-directional dead end pressure rating of 285 psi, and temperature rating of -20 to 300 degrees F. Construction features to include 316 SS electroless nickel plated eccentric rotating disc, dynamic sealed, PTFE seal ring, 17-4 Ph (ASTM A 564 Cind. H1075 or H1100) stainless steel shaft, TFE chevron stem packing SS/DU TFE removal of downstream piping and shall be factory pressure tested to 110% of pressure rating. Valves shall be installed by use of cap screws; threaded rod not acceptable. Tyco

Keystone Figure 312 or equal.

2.10 ACTUATORS

Electronic

Design for direct mounting on the device and attachment to the driving shaft (damper actuator only); adjustable angle of rotation or range of actuation; and built in overload protection. Size each motor for 150% of the application requirement and with sufficient reserve power to provide smooth action.

Modulating actuators shall use a 0-10 VDC or 4-20 mAD signal input to match DDC device AO signal output, and 24 VAC power. Three-wire, bi-directional motor actuators controlled by BO point pairs are acceptable on terminal valve boxes, terminal heating/reheat coils, and fan coil units only.
Two-position actuators shall be a 120 VAC, two-wire, spring return. Spring actuation return actuation time shall be less than 30 seconds.
Damper Actuators - 95° rotation maximum, with built-in adjustable mechanical stop to limit rotation to that of the damper and/or to meet TAB requirements.
End switches- Provide actuator with integral, adjustable-position indication end switches (one for each fully actuated position) when the actuated device is specified with an end switch binary input point(s).

Provide valve actuators capable of close-off against a pressure greater than the respective pump system shut-off head.

Failsafe: Provide spring-return failsafe upon loss of power or control signal to the positions as follows:

OA dampers- N.C.
Mixed-air dampers- N.O.
Relief- and exhaust-air dampers- N.C.
HW coil valves- N.O.
CHW Valves – N.O.

2.11 POWER SUPPLIES AND LINE FILTERING

Control transformers shall be UL Listed. Furnish Class 2 current limiting type, or furnish over-current protection in both primary and secondary circuits for Class 2 service per NEC requirements. Limit connected loads to 80% of rated capacity.

DC power supply output shall match output current and voltage requirements. Unit shall be full-wave rectifier type with output ripple of 5.0 mV maximum peak to peak. Regulation shall be 1.0% line and load combined, with 100 microsecond response time for 50% load changes. Unit shall have built in over-voltage and over-current protection, and shall be able to withstand a 150% current overload for at least 3 seconds without trip-out or failure.

Unit shall operate between 0°C and 50°C (32°F and 120°F). EM/RF shall meet FCC Class B and VDE 0871 for Class B, and MIL-STD 810C for shock and vibration.
Line voltage units shall be UL Recognized and CSA Approved.

Power line filtering:

DC power supply output shall match output current and voltage requirements. Unit shall be full-wave rectifier type with output ripple of 5.0 mV maximum peak to peak. Regulation shall be 1.0% line and load combined, with 100 microsecond response time for 50% load changes. Unit shall have built in over-voltage and over-current protection, and shall be able to withstand a 150% current overload for at least 3 seconds without trip-out or failure.

Dielectric strength of 1,000 volts minimum.
Response time of 10 nanoseconds or less.
Transverse mode noise attenuation of 65 dB or greater.
Common mode noise attenuation of 150 dB or better at 40 Hz to 100 HZ.

2.12 WIRING AND RACEWAYS

General: Provide copper wiring, plenum cable, and raceways as specified in the applicable sections of Division 26.

All insulated wire to be copper conductors, UL labeled for 90C minimum service.

All exposed wiring shall be installed in conduit.

Conduits shall not exceed 40 percent maximum fill for single conductor and jacketed cables.

2.13 SENSORS/TRANSMITTERS

All input accuracies required by this section shall be end-to-end (from sensing point to BAS display). End-to-end accuracy includes all errors due to the sensor, transmitter, wiring and BAS signal measurement and A/D conversion.

Thermistors or solid state sensors shall be provided for temperature sensing applications except where accuracies or ranges required cannot be met by these devices, RTD's shall be used. The sensors shall be powered by the BAS Panel or Dedicated Controller. The solid state sensors shall be accurate to within +/- 0.5 degree F over the following ranges and meet the following requirements:

Room Type Instruments: 50 degree F to 100 degree F. Sensor shall be surface mounted with a ventilated cover, insulated baseplate and vandalproof screws.

Provide smooth, blank cover plate on all room temperature sensors.

Duct and Plenum Applications: -30 degree F to 240 degree F. Supply, return, exhaust or mixed air averaging type, which shall have an extended element of sufficient length to cover the entire duct cross-section with a minimum of three (3) passes. If a single averaging thermistor of sufficient length to meet the preceding are not available, then two (2) or more sensors and AIs shall be used and averaged in software.

Where RTD's are required, they shall be 1,000 OHM platinum type and be supplied with a 4-20 mA DC transmitter. The sensor and transmitter shall be a single unit. They shall be accurate to within +/- 1.0 degree F over the range of 32 degree F to 600 degree F.

Where thermocouples are required, they shall be Type J and be supplied with a 4-20 mA DC transmitter. They shall be accurate to within +/- 2.0 degree F over the range of 32 degree F to 1,300 degree F.

Provide matched temperature sensors for applications which require both inlet and outlet temperatures of any device. Where a “Matched Temperature Sensor Pair” is shown/specified, the sensors shall be tested and documented by the sensor manufacturer as being accurate to within 0.1°F of each other.

Outdoor Air Temperature and Humidity Transmitter:

Provide Vaisala HMT 130 relative humidity and temperature probe with installation kit and radiation shield DTR502B. Probe shall have a temperature measuring range of -40 degree C to +80 degree C with an accuracy of +/- .4 degree C at 68 over the range of the sensor and relative humidity measuring range of 0 to 100 percent RH with an accuracy of 3 percent, 0 to 90 percent RH with a repeatability better than 1 percent RH per year. RH and temperature probe shall be capable of a continuous temperature operating range of -40 degree F to +120 degree F. Provide necessary transmitter for output signals.

Pressure Sensors, Transmitters and Differential Switches:

Air Differential Pressure Transmitters shall be Modus Model T30 or T40 (as required) with an accuracy of +/- 1 percent of range (including non-linearity and hysteresis), solid state circuitry, no moving parts, capacitance principle capable of sensing positive, negative and differential pressures. Transmitter shall have 4-20 mA output signal and be powered by the control system or dedicated controller and capable of withstanding momentary overpressure of eight (8) times the pressure range.
Differential air pressure switches for filter or proof of airflow status shall be Dwyer Series 1910, with automatic reset, SPDT.

Air and Vacuum Pressure Transmitter: Kele and Associates Model P100GTE, solid state, 4-20 mA signal, with a full scale accuracy of 1 percent

Flow Elements/Transducers:

VAV terminal Unit: Provide differential-pressure transducer integral to the application-specific controller. Connect to pitot-tube element provided with terminal unit.
Water Flow: Provide Onicon F-1200 series dual turbine insertion flow meter.

Differential Pressure Sensors: Differential pressure sensors (air or water) shall be temperature compensated with an accuracy of +/-1% of range and hysteresis of 0.5% of range.

Air: Sensor shall be able to withstand a maximum port pressure of 10psig.
Water: Wetted parts shall be stainless steel; sensor shall be able to withstand a maximum port pressure of 250psig and a maximum differential pressure of 150psi or 300% of the rated range, whichever is greater.

Wall/Duct Mount CO_2 Transmitter:

Description; Measure and transmit CO_2 levels ranging from 0 to 2,000 parts per million ppm. Silicone-based CARBOCAP® sensor delivers high accuracy and long-term measurement stability ($\pm$100 ppm) over a five-year period without calibration. It shall consist of an infrared (IR) source, a sample cell, and IR detector, and a tunable interference filter that enables measurements at two wave lengths. Reference measurements made using a tunable interference filter.
Model;

Wall Model; CD-Wxx-00-0 Wall Mount CO_2 transmitter.
Duct Model; CD-Pxx-00-0 Series Duct Mount CO_2 transmitter.

Specifications;

Measuring Range: 0 to-2000ppm CO_2.
Accuracy at 77°: $<\pm$ 30m ppm+ 2.0% of reading, includes manufacturing deviation and drift.
Non-Linearity: <0.5% of Full Scale.
Temperature Dependence of Output: <0.056% of Full Scale/F°.
Response Time (0 to 63%): 1 Minute.
Operating Temperature Range: 23 to 113°F
Humidity Range: 0 to 85% RH (non-condensing)
Power Supply Range: 20 to 30 VAC (18 to 30 VDC), Class 2.
Power Consumption: <2.5 W Average, 4.1 VA.
Air Flow Range: 0 to 7,500 ft/minute
Duct Probe Material: Duct probe meets plenum rating requirements of UL 1995, Heating and Cooling Equipment.
Agency Listings: UL Listed, CCN XAPX

2.14 POWER MONITORING

General: Provide current switches, current transducers, voltage transducers, current transformers as required to meet the specified Sequence of Operation and indicated below.

Current Operated Switches: AC current switch, Neilsen - Kuljian Model PD50AC, or PD75, solid state, five (5) year warranty, three (3) selectable ranges for optimum adjustability and resolution. Provide external current transformer where required.

Current Transducers: AC current to DC current output, +/- .5 percent accuracy, 4-20 mA output signal, Kele and Associates Model 4CMA. Provide external current transformer where required.

Voltage Transducers: Kele and Associates Model PVM or LVM as required for each application, +/- 1/2 percent accuracy, 4-20 mA DC output.

2.15 TEMPERATURE CONTROL CABINETS

General: All controllers and field interface devices shall be installed in control panel cabinet/enclosure as described below.

Cabinets shall be UL listed, 14 gauge furniture grade steel, finished with baked enamel painted finish inside and out, cabinet doors shall have piano hinge and standard key cylinder locking latch.

All devices installed in or on the control cabinet shall be labeled with a fixed mounted, color contrasted, engraved laminated plastic tags, including describing the function of the device, similar to the following example:

ΔP TRANSMITTER DEVICE

Label

DSP-1, AHU-1 SUPPLY DUCT STATIC PRESSURE TRANSMITTER

All electrical devices within the panel shall be prewired to terminal strips with all inter-device wiring within the panel completed prior to installation of the system.

Mount control panels adjacent to associated equipment on vibration free walls or free standing steel angle supports or "Unistrut" support stand.

2.16 VARIABLE FREQUENCY DRIVES

Variable frequency drives shall be arranged so they can be operated in an open circuit mode, disconnected from the motors, for start-up adjustments and trouble shooting.

Wire all safeties to operate both in hand and auto positions as well as drive and by-pass sections.

Provide BacNet communication cabling and interface necessary to forward VFD computer communication information to and from the BAS/VFD. See Division 23.

2.17 END SWITCHES

All end switches shall be NEMA rated contacts and NEMA 4X enclosure, either SPDT, DPDT DPST as required to meet the Sequence of Operation, complete the Points List and necessary interlocks or safeties control wiring. End switches shall be as manufactured by Cutler-Hammer or Allen-Bradley.

All end switches shall be designed and configured to provide positive indication of a control device (i.e. damper or valve) position for the service intended.

PART 3 - EXECUTION

3.0 INSTALLATION

The Contractor shall install all equipment, control air piping/tubing, conduit and wiring parallel to building lines.

All automatic control valves and control dampers furnished by the Temperature Control Contractor shall be installed under his supervision by the Mechanical Contractor.

GENERAL INSTALLATION REQUIREMENTS:

Spare conductor capacity, equal to a minimum of two (2) additional sensors shall be provided to each underfloor sensor and pendant type sensors.
Horizontal runs of conduit, trays, tubing or wiring shall be hung from structural members using new supports. Single runs of conduit, tubing or wire shall be by clevis ring and all thread rod. Multiple runs shall be by "Trapeze" or "Unistrut" supports. "Plumber's Strap" shall not be allowed. Maximum distance between supports shall be per the NEC.
All vertical runs of conduit or tubing shall be through new core drills. The installation shall be supported above each floor penetration using clamps to "Unistrut".
All wire that enters or leaves a building structure shall be installed with lightning protection per NEC.
All wire terminations shall be with compression type round hole spade lugs under a pan head screw landing; Stay-Kon or equivalent. All wire splices shall be with compression type insulated splice connectors or properly sized "wire-nut" connectors. Hand twisted, soldered and/or taped terminations or splices are not acceptable.
Where tubing, wiring or conduit penetrate floors or walls, sleeves with bushings shall be provided for tubing and wires. The conduit or sleeve opening shall be sealed with fire proof packing so the smoke and fire rating of the wall or floor is maintained.
Under no circumstances shall wire, tubing, tray, J-boxes or any BAS equipment be run in, mounted on, or suspended from any of the telephone system's equipment, cable trays or support structure (Grey Iron).
All the material installed under this contract must be mounted on, or supported from the building structure or supports furnished by this Contractor.

Control Wiring:

Run wiring in metallic conduit, tubing or raceways. Exceptions are as follows:

NEC Class 2 low voltage wiring where not exposed to view such as above suspended ceilings, in shafts, etc., may be run in cable (when approved by Code Authority).
Wiring enclosed in temperature control panels.

Where conduit is used, provide steel fittings.

Low Voltage Conductors: 18 Gauge minimum, except 19 gauge may be used for home runs to central panels and 22 gauge minimum for resistance or thermistor sensing element connections.

Wire control interlocks and control panels, except one (1) 120V power circuit to each temperature control panel shown on drawings and schedules shall be provided under Division 1.

All wiring shall comply with the requirements of Local and National Electrical Codes.

Do not interlock alarms with starter switching to bypass alarm when equipment is manually disconnected.

All costs of controls, wiring conduit and associated labor shall be included in the Temperature Control Bid. The control wiring shall be installed under the supervision of this Contractor.

3.1 ENCLOSURES

The tubing and wiring within all enclosures shall be run in plastic trays. Tubing and wiring within BAS panels may be run using adhesive-backed tie wraps.

All plastic tubing shall be connected to enclosures through conduit. All copper tubing shall be connected to enclosures through bulkhead fittings.

Mount all enclosures, including those which house BAS Panels, Slaves and Field Device Panels, so that the top of the enclosure does not exceed six feet, six inches (6'-6"); and the center of any keypad/LCD combination does not exceed five foot, six inches (5'-6") from the floor or is less than four feet, zero inches (4'-0") from the floor.

Field Device Panels contain related Field Devices such as relays, control power (24V) transformers, output transducers, etc., that are outboard of the BAS Panels or Dedicated Controllers. Each Field Device shall be mounted within an enclosure. The enclosures shall be provided with lockable latches that will accept a single key common to all Field Device Panels, BAS Panels and Slaves.

3.2 INSTALLATION PRACTICES

The Contractor shall install and calibrate all Field Devices, Sensors and Transducers necessary for the complete operation of the I/O Points described herein.

Sensors shall be removable without shutting down the system in which they are installed.

All immersion sensors shall be installed in new, welded thermowells supplied by the Contractor.

Thermistor wire leads shall be permanently terminated at panels or controllers with wire clamps.

Furnish and install pressure/temperature gauges adjacent to each immersion type sensor.

Sensors shall be installed with the use of a wet or hot tap without draining the system if required.

3.3 IDENTIFICATION

All control J-boxes, conduit, and wiring shall be labeled.

Electrical devices, wiring, conduit and J-boxes shall be labeled and identified as required by Division 26.

As a minimum regardless of Division 26 requirements, all temperature control J-box covers shall be painted Blue in color on both sides of cover.

Identification shall be provided for all enclosures, panels, junction boxes, controllers or field devices. Laminated, bakelite nameplates shall be used. The nameplates shall be 1/16-inch thick and a minimum of 1-inch by 2-inches. The lettering shall be White on a Blue background with minimum 1/4-inch high engraved letters. The nameplates shall be installed with pop rivets.

All new devices will be tagged. Color code to differentiate between new devices.

Thoroughly clean the surface to which the label shall be applied with a solvent before applying the identification. Use an epoxy to affix the identification in addition to any adhesive backing on the identification.

The Plan Code Designation shown on all shop drawing identification shall be consistent with the Contract Documents.

All I/O Field Devices that are not mounted within Field Device Panel enclosures shall be identified with engraved plastic laminated nameplates installed so that they are visible from ground level.

The identification shall show the designation used on the Record Documents and identify the function such as "Mixed Air Temperature Sensor" and "Fan Status DP Switch".

Calibration settings shall be marked with paint or indelible ink.

3.4 LOCATIONS

All sensing devices and locations shall be located by the Contractor as shown on the submittal shop drawings with final review by the Engineer.

Wall mount space sensors shall be mounted 42" above finished floor. Pendant mount space sensors shall be mounted 8-feet above finished floor.

Enclosures housing Field Devices shall be located immediately adjacent horizontally to the BAS Panels or Slaves which are being interfaced to.

3.5 TEMPERATURE SENSORS

Temperature controls trades shall verify all wall mounted temperature sensors locations with the Architect/Engineer/Owner in order to avoid interference with wall mounted and space furnishings.

Where interferences require moving the temperature sensor more than two (2) feet, consult with the Architect/Engineer for relocation.

Temperature sensors shall be mounted on suitable insulated base and secured to the wall in such a way as to be easily removed from wall without damage to the sensor.

Check and verify location of thermostats and other exposed control sensors with plans and room details before installation. Locate thermostats 42" above floor.

3.6 EQUIPMENT PROTECTION AND COORDINATION

Extreme care must be exercised while working around operating equipment, particularly sensitive telephone switching and computer equipment. Close coordination with the Owner is required for the protection of this operating equipment from dust, dirt and construction material while maintaining the operational environment for the equipment. Under no circumstances shall the power or environmental requirements of the operating equipment be interrupted during the installation and check-out without submitting to the Architect, Owner and Engineer for approval.

3.7 CLEANUP

At the completion of the work, all equipment pertinent to this contract shall be checked and thoroughly cleaned and all other areas shall be cleaned around equipment provided under this contract. Clean the exposed surfaces of tubing, hangers, and other exposed metal of all grease, plaster, dust, or other foreign materials.

Upon final completion of work in an area, vacuum and/or damp wipe all finished room surfaces and furnishings. Use extreme care in cleaning around telephone switching and computer equipment and under no circumstances shall water or solvents be used around this equipment.

At the completion of the Work and at the end of each workday, remove from the building, the premises, and surrounding streets, etc., all rubbish and debris resulting from the operations and leave all equipment spaces absolutely clean and ready for use.

3.8 SOFTWARE, DATABASE AND GRAPHICS

Software Installation: The Contractor shall provide all labor necessary to install, initialize, start-up and debug all system software as described in this section. This includes any operating system software or other third party software necessary for successful operation of the system.

Database Configuration: The Contractor will provide all labor to configure those portions of the database that are required by the Points List and Sequence of Operation.

Color Graphics: Unless otherwise directed by the Owner, the Contractor will provide color graphic displays for all systems which are specified with a Sequence of Operation, depicted in the Mechanical Drawings for each system and floor plan. For each system or floor plan, the display shall contain the associated points identified in the Point List and allow for set point changes as required by the Owner.

3.9 TEMPERATURE CONTROL DRAWINGS

Upon completion of project and after record drawings of the temperature controls have been prepared and reviewed, the Contractor shall provide one (1) complete set of Temperature Controls Drawings at each Temperature Control Panel. Each set of drawings shall be laminated in a plastic coating. The drawings shall consist of only those control functions associated with the specific control panel and any relevant or pertinent network interface information.

The laminated drawings shall have a grommet connection attached to a metal cable or chain which is mechanically fastened to the Temperature Control Cabinet.

3.10 START-UP AND TESTING

Prior to Beneficial Use of the BAS, the Contractor shall supply to Architect/Engineer two (2) debugged printouts of all software entered into the BAS. Also supply all user's programming and engineering manuals required to interpret the software. Included in the printouts, though not limited to, shall be the following:

Point data base.
All custom control programs written in the BAS control language.
All parameters required for proper operation of BAS control and utility firmware such as start-stop routines, etc.
Printouts or plotted detailed copies of the complete interactive system graphics.

The software printout shall be fully documented for ease of interpretation by the Architect/Engineer and Owner, without assistance from the Contractor. English language descriptions shall be either integrated with or attached to the BAS printout. Specifically, the following shall be documented:

All point (I/O and virtual) names.
All BAS Programming Language commands, functions, syntax, operators, and reserved variables.
Use of all BAS firmware.
The intended actions, decisions, and calculations of each line or logical group of lines in the custom control program(s). Sequences of operation are not acceptable for use in this documentation requirement.
Complete descriptions of and theories explaining all software and firmware algorithms. The algorithms to be described include, but are not limited to, PID, optimum start/stop, demand limiting, etc.

Documentation that was supplied as part of the submittals need not be submitted at this time.

Upon review of software, a Point-To-Point Test of the BAS installation shall commence. The Contractor shall provide two (2) people equipped with two-way communication and shall test actual field operation of each control and sensing point. This procedure shall occur during off-hour periods. The purpose is to test the calibration, response, and action of every point. Any test equipment required to prove the proper operation of the BAS shall be provided by and operated by the Contractor. Demonstrate compliance that system functions per the Sequence of Operation.

Upon review of the Point-To-Point demonstration, the Contractor shall start up the BAS by putting all controlled equipment in automatic and enabling software. Contractor shall commence final software and overall BAS hardware/software debugging.

Final acceptance of the BAS is contingent upon a hardware/software system test. All groups of points that yield a system of control shall be tested for compliance with the sequences of operation. Included in the test, but not limited to, shall be:

BAS Loop Response. The Contractor shall supply a trend data output in graphical form showing the step response of each BAS loop. The test shall show the loop's response to a change in set point which represents a change in the actuator position of at least 25 percent of its full range. The sampling rate of the trend shall be from one (1) to three (3) minutes depending on the speed of the loop. The trend data shall show for each sample the set point, actuator position, and controlled variable values. Any loop that does not yield temperature control of + 0.2 degree F or humidity control of + 3 percent RH shall require further tuning by the Contractor.

Interlocks and other sequences.
BAS Control under HVAC equipment failure.
HVAC Operation under BAS equipment failure.
Battery backup.
BAS Control under power failure/restart.
Reset schedules.
BAS Alarm reporting capability.

A detailed test report as defined under Submittals shall be provided indicating its completion and proper system operation.

The BAS will not be accepted as meeting the requirements of Beneficial Use until all tests described in this section have been performed to the satisfaction of both the Architect/Engineer and Owner. Any tests that cannot be performed due to circumstances beyond the control of the Contractor shall be exempt from the Beneficial Use requirements if requested in writing by the

Contractor and concurred by the Owner and Architect/Engineer. Such tests shall be performed as part of the BAS Warranty.

A typed written document stating that the system has been fully checked out on a point by point basis shall be submitted to the Architect/Engineer. All documentation associated with the check out shall be included.

3.11 PROJECT RECORD DOCUMENTS

Prior to final completion of the installation, prepare a complete set of Record Drawings on a clear and legible set of ANSI size 'B' (11" x 17") reproducible prints. The content, format and procedure of the submittal shall be as described by the General Conditions.

Provide one (1) laminated and framed set of Control Drawings for each new BAS Control Panel and one (1) for the Facility Control Room, locate as directed by the Engineer.

Prior to final completion of the installation, prepare two (2) hard copies and one (1) electronic copy (CD or DVD) of the Operation and Maintenance Manuals. The information is to be or provided in a tabbed and index, three (3) screw and post binder. The information shall include:

Operator's Manual with step-by-step procedures for logging On/Off, interrogating the system, producing reports, acknowledging alarms, overriding computer control, and changing firmware parameters.

Programmer's manual with complete description of the custom control language and associated editor, including sample written programs. Provide complete sets of all programming forms, applications memorandums, and addenda to the programmer's manual. All software or firmware algorithms shall be completely described and documented.

Maintenance, Installation, and Engineering Manual(s) that clearly explains how to debug hardware problems, how to repair or replace hardware, preventive maintenance guidelines and schedules, calibration procedures, and how to engineer and install new points, panels, and operator interfaces.

Documentation of all software. List separately all software parameters that will need updating by the Owner such as, though not limited to, holiday, seasonal and start/stop schedules, comfort and duty cycling schedules.

All programs, passwords, code, databases, graphic files, CADD drawings and symbol libraries generated for operation of the system shall be included as a part of the system documentation. This information shall be submitted both in hard copy bound format and magnetic media format.

Input/Output schedules, data sheets, and all other items required under Submittals.

Describe all regular maintenance that will need to be performed on the BAS hardware.

List replacement parts with part numbers.

Complete original issue documentation and software diskettes for all third party software furnished and installed as a part of the system or required for the operation of the system including text editors, control language program and compiler, database managers, graphics and CADD packages, operating systems and communications software.

Complete original issue documentation, installation and operational manuals and supporting software for all third party hardware furnished and installed as a part of the system or required for the operation of the system including remote terminals, user's computer workstation, monitors, graphics and memory boards, printers and modems.

During the warranty period, all copies of the drawings and manuals shall be updated to include all hardware and software changes.

All of the above documentation shall record the equipment installed under this contract.

The Record Drawings shall document the complete control system. This includes all mechanical equipment in work area which has automatic control.

3.12 WARRANTY

The Warranty period shall begin on the date of Beneficial Use Completion as authorized by the Architect/Engineer and Owner in writing. Beneficial use shall not occur before the Contractor has performed the tests required. With these requirements met, beneficial use shall not occur until, in the opinion of the Architect/Engineer, the BAS is sufficiently complete to be utilized for the purposes for which it is intended.

The warranty start date shall not begin until all phases of the Project are complete, i.e., the Project shall have a single warranty start date.

The BAS System shall be guaranteed to be free from defects in material and workmanship and in software design and operation for the period of the warranty after completion of the contract. The Contractor shall provide the necessary skills, labor, and parts to assure the proper operation of, and to provide all required current and preventive maintenance. This warranty shall become effective starting the date of Beneficial Use completion.

The hardware warranty shall include all equipment which has been purchased by the Contractor.
The Contractor shall respond to all calls during the warranty period for all problems or questions experienced in the operation of the installed equipment and shall take steps to correct any deficiencies that may exist.
The response time to any problems shall be four (4) hours maximum (twenty-four) 24-hours per day, seven (7) days per week. Corrective action, temporary or permanent, shall be made within one (1) business day.

The Contractor shall maintain on site a backup of all BAS software installed in the system. The backup shall be updated monthly or whenever a change to the software is made. A reload of backup software into the system shall be performed by the Contractor immediately upon notification by the Owner. The reload shall be free of charge unless it is due to a power failure of a duration longer than the battery backup.

The Contractor shall optimize all control software to assure acceptable operating and space conditions, and peak energy efficiency.

3.13 TRAINING

The Contractor shall provide two 2 hours of training for the Owner’s Representative. The training sessions shall be broken into one 1 2-hour session. The training session shall be made available to the Owner prior to the end of the warranty period, but after final completion of the contract. The session shall be given at the Owner's facility. Scheduling shall be approved by the Owner. The training shall focus on general design, operation, and maintenance procedures of the products installed, though not necessarily the specific system designed, and shall cover:

Hardware configuration including PC boards, switches, communication and point wiring, and location and installation of all sensors and control devices.
Hardware maintenance, calibration, troubleshooting, diagnostics, and repair instructions.
Operation of man-machine interface including logging On/Off, interrogating the system, producing reports, acknowledging alarms, overriding computer control, and changing firmware/software parameters.
Programming the BAS using the editor and the design of custom control software.
Recovery procedures from both BAS and HVAC failures.

The Instructor for the above session shall be an employee of the Contractor, who is qualified to provide customer training and applications support.

END OF SECTION 23 09 00

SECTION 23 11 23
NATURAL GAS SYSTEMS

PART 1 - GENERAL

1.0 DESCRIPTION OF WORK

This Section includes Distribution Piping Systems for natural gas within the building and extending from the point of delivery to the connections with gas utilization devices. Piping materials and equipment specified in this section include:

Pipes, Fittings, and Specialties
Special Duty Valves

Gas pressures for systems specified in this section are limited to 5 psig.

Products installed but not furnished under this section include gas meters, which will be provided by the Utility Company to the site ready for installation.

1.1 DEFINITIONS

Pipe sizes used in this specification are Nominal Pipe Size (NPS).

Gas Distribution Piping: A pipe within the building, which conveys gas from the point of delivery to the points of usage.

Gas Service Piping: The pipe from the gas main or other source of supply including the meter, regulating valve, or service valve to the gas distribution system of the building served.

Point of Delivery is the outlet of the service meter assembly, or the outlet of the service regulator (service shutoff valve when no meter is provided).

1.2 QUALITY ASSURANCE

Manufacturer's Qualifications: Firms regularly engaged in manufacture of natural gas systems products, of types, materials, sizes required, whose products have been in satisfactory use in similar service for not less than five (5) years.

Installer Qualifications: Installation and replacement of gas piping, gas utilization equipment or accessories, and repair and servicing of equipment shall be performed only by a qualified installer. The term qualified is defined as experienced in such work (experienced shall mean having a minimum of five (5) previous projects similar in size and scope to this project), familiar with precautions required, and has complied with the requirements of the Authority Having Jurisdiction. Upon request, submit evidence of such qualifications to the Architect.

Qualifications for Welding Processes and Operators: Comply with the requirements of ASME Boiler and Pressure Vessel Code, "Welding and Brazing Qualification".

Regulatory Requirements: Comply with the requirements of the following codes:

NFPA 54 - National Fuel Gas Code, for gas piping materials and components, gas piping installations, and inspection, testing, and purging of gas piping systems.
Local Building Code.
Utility Compliance: Fabricate and install natural gas systems in accordance with Local Gas Utility Company.

IFGC Compliance: Fabricate and install natural gas systems in accordance with "International Fuel Gas Code".

1.3 SUBMITTALS

Submit in accordance with Division 1.

Welders' qualification certificates, certifying that welders comply with the quality requirements specified under "Quality Assurance" below.

1.4 CLOSEOUT SUBMITTALS

Submit in accordance with Division 1.

Spare Parts: Furnish to Owner, with receipt, two (2) valve wrenches for each type of gas valve installed.

Test Reports specified in PART 3 below.

1.5 DELIVERY, STORAGE, AND HANDLING

Handling Flammable Liquids: Remove and legally dispose of liquid from drips in existing gas piping and handle cautiously to avoid spillage or ignition. Notify the gas supplier. Handle flammable liquids used by the installer with proper precautions, and do not leave on the premises from the end of one (1) working day to the beginning of the next.

1.6 SEQUENCING AND SCHEDULING

Notification of Interruption of Service: Except in the case of an emergency, notify all affected users when the gas supply is to be turned off.

Work Interruptions: When interruptions in work occur while repairs or alterations are being made to an existing piping system, leave the system in safe condition.

Coordinate the installation of pipe sleeves for foundation wall penetrations.

PART 2 - PRODUCTS

2.0 PIPING AND FITTINGS

Above Grade Exposed Locations:

Pipe 2-Inches and Smaller: ASTM A 53, Grade B, Type E, Schedule 40 black steel pipe, electric resistance welded.

Fittings:

Malleable Iron Threaded Fittings: ANSI B16.3; (Class 125 and 300).
Malleable Iron Threaded Unions: ANSI B16.30, Class 150, 250 or 300; selected by Installer for proper piping fabrication and service requirements, including style, end connections, and metal-to-metal seats (iron, bronze or brass).
Forged Steel Socket-Welded and Threaded Fittings: ANSI B16.11, except MSS SP-79 for threaded reducer inserts; rated to match schedule of connected pipe (up to 4-inch pipe size).

Pipe 2-1/2 Inch and Larger: ASTM A 53, Grade B, Type S, Schedule 40 seamless black steel pipe.

Fittings:

Steel Flanges/Fittings: ANSI B16.5, including bolting and gasketing of the following material group, end connection and facing, except as otherwise indicated.

Material Group: Group 1.1
End Connections: Butt-weld
Facings: Raised-face

Forged Steel Socket-Welded and Threaded Fittings: ANSI B16.11, except MSS SP-79 for threaded reducer inserts; rated to match schedule of connected pipe (up to 4-inch pipe size).

Wrought Steel Butt-Welded Fittings: ANSI B16.9, except ANSI B16.28 for short-radius elbows and returns; rated to match connected pipe.

Above Grade Concealed Locations:

Piping all sizes: ASTM A 53, Grade B, Type S, Schedule 40 seamless black steel pipe.

Fittings:

Steel Flanges/Fittings: ANSI B16.5, including bolting and gasketing of the following material group, end connection and facing, except as otherwise indicated.

Material Group: Group 1.1
End Connections: Butt weld
Facings: Raised-face

Wrought Steel Butt-Welded Fittings: ANSI B16.9, except ANSI B16.28 for short-radius elbows and returns; rated to match connected pipe.

Below Grade: Outside Building

Piping all sizes: Plastic pipe, polyethylene, tubing and fittings shall conform to ASTM D 2513. Pipe shall be marked “Gas” and “ASTM D 2513”.

Transition risers; factory assembled anodeless riser shall be designed and certified to meet the requirements of category I of ASTM D 2513 and U.S. Department of transportation, Code of Federal Regulation, title 49, part 192.281 (e).
Tracer wire; yellow insulated copper tracer wire. Install adjacent to underground piping. Terminate above ground at each end of the piping. Minimum wire size si 18 AWG, and shall be suitable for direct burial.

2.1 VALVES

Special Duty Valves are specified in this section by their generic name. Refer to PART 3, "VALVE APPLICATION", for specific uses and applications for valve specified.

Gas Cocks 2-Inch and Smaller: 150 psi WOG, bronze body, straightaway pattern, square head, threaded ends. Acceptable Manufacturers: Lunkenheimer, Nibco, Powell, Stockham.

Ball Valves: 2-Inch and Smaller: MSS-SP-110, 150 psi SWP, 600 psi WOG, two-piece ASTM B584 cast bronze body, full port, chrome plated brass/bronze ball, TFE seats, anti-blowout stem separate packnut with adjustable stem packing, extended stem, and vinyl covered steel handle. Threaded end connections.

Gas Cocks 2-1/2 Inch and Larger: MSS SP-78; 175 psi, lubricated plug type, semi-steel body, single gland, wrench operated, flanged ends. Acceptable Manufacturers: Lunkenheimer, Nibco, Powell, Stockham.

Solenoid Valves: Aluminum body, 120 volts AC, 60 Hz, Class B continuous duty molded coil; NEMA 4 coil enclosure; electrically opened/electrically closed; dual coils; normally closed; UL and FM approved and labeled.

Gas Line Pressure Regulators: Single-stage, steel jacketed, corrosion-resistant gas pressure regulators; with atmospheric vent, elevation compensator; with threaded ends for 2-inch and smaller, flanged ends for 2-1/2 inch and larger; for inlet and outlet gas pressures, specific gravity, and volume flow indicated.

PART 3 - EXECUTION

3.0 PREPARATION

Precautions: Before turning off the gas to the premises, or section of piping, turn off all equipment valves. Perform a leakage test as specified in "FIELD QUALITY CONTROL" below, to determine that all equipment is turned off in the piping section to be affected.

Conform to the requirements in NFPA 54, for the prevention of accidental ignition.

3.1 PIPING INSTALLATION

Conform to the requirements of NFPA 54 - National Fuel Gas Code.

Locations and Arrangements: Drawings indicate the general location and arrangement of piping systems. Design locations and arrangements of piping take into consideration pipe sizing, flow direction, slope of pipe, expansion, and other design considerations. So far as practical, install piping as indicated.

Concealed Locations: Except as specified below, install concealed gas piping in an airtight conduit constructed of Schedule 40, seamless Black steel with welded joints. Vent conduit to the outside and terminate with a screened vent cap.

Above-Ceiling Locations: Gas piping may be installed in accessible above-ceiling spaces (subject to the approval of the Authority Having Jurisdiction), whether or not such spaces are used as a plenum. Valves shall not be located in such spaces.
Gas Piping in solid floors such as concrete shall be laid in channels in the floor and covered to permit access to the piping with a minimum of damage to the building. Where piping in flow channels could be exposed to excessive moisture or corrosive substances, the piping shall be protected in an approved manner.

Piping In Partitions: Concealed piping shall not be located in solid partitions. Tubing shall not be run inside hollow walls or partitions unless protected against physical damage. This does not apply to tubing passing through walls or partitions.
Prohibited Locations: Do not install gas piping in or through a circulating air duct, clothes chute, chimney or gas vent, ventilating duct, dumb waiter or elevator shaft. This does not apply to accessible above-ceiling space specified above. Piping shall not be installed beneath slab on grade floors.

Install pipe sleeve and seals at foundation and basement wall penetrations.

Seal pipe penetrations of fire barriers using fire barrier penetration sealers.

Drips and Sediment Traps: Install a drip leg at points where condensate may collect, at the outlet of the gas meter, and in a location readily accessible to permit cleaning and emptying. Do not install drips where condensate is likely to freeze.

Construct drips and sediment traps using a tee fitting with the bottom outlet plugged or capped. Use a minimum of three (3) pipe diameters in length for the drip leg. Use same size pipe for drip leg as the connected pipe.

Use fittings for all changes in direction and all branch connections.

Install gas piping at a uniform grade upward to risers, and from the risers to the meter, or service regulator when meter is not provided, or the equipment.

Connect branch outlet pipes from the top of horizontal lines, not from the bottom or sides.

Refer to “Supports and Anchors” specification section.

Natural Gas Piping installed on the roof shall be on roller supports.

3.2 TESTING

General: Provide temporary equipment for testing including pump and gauges. Test before insulation is installed. Test piping to be concealed prior to permanent enclosure.

Provide the Engineer a minimum of twenty-four hours’ notice of dates when acceptance test will be conducted. Conduct tests in presence of representative of agency having jurisdiction.

Examine system to see that equipment and parts that cannot withstand test pressures are properly isolated.

System Tests:

Compressed Air Test: Pressurize the system to 100 psig or 1.5 times the design pressure, whichever is greater. Maintain pressure until the entire system has been inspected for leaks, but in no case for a time period of less than four (4) hours.
Maintain test pressure until the entire system has been inspected for leaks, but in no case less than four hours. Examine all piping, joints, and connections for leakage.

Repair failed piping sections by disassembly and re-installation, using new materials to extent required to overcome leakage. Do not use chemicals, stop-leak compounds, mastics, or other temporary repair methods.

Prepare written report of testing, indication locations of leaks corrected, method used to correct leaks, number of tests required, and certification that system is leak free. Provide three (3) copies of test results.

3.3 NATURAL GAS PIPING SPECIALTIES

Gas Meters:

Prepare for installation of gas meter in accordance with local Utility Company's installation instructions, and comply with requirements.
Set meter on concrete pad as indicated.

Protective Coating:

Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.

Alkyd System: MPI EXT 5.1D.

Prime Coat: Alkyd anticorrosive metal primer.
Intermediate Coat: Exterior alkyd enamel matching topcoat.
Topcoat: Exterior alkyd enamel (flat).
Color: Gray.

Paint exposed, interior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.

Latex Over Alkyd Primer System: MPI INT 5.1Q.

Prime Coat: Alkyd anticorrosive metal primer.
Intermediate Coat: Interior latex matching topcoat.
Topcoat: Interior latex (flat).
Color: Gray.

Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

Flexible Connectors:

Provide flexible connectors with full size quick coupler for all kitchen and heavy moveable gas appliance equipment.
Connectors shall be of lengths required to displace equipment for complete cleaning under and around gas appliance.

3.4 VALVE APPLICATIONS

General: The Drawings indicate valve types, locations, and arrangements.

Shutoff Duty: Use gas cocks.

3.5 VALVE INSTALLATIONS

Install valves in accessible locations, protected from physical damage. Tag valves with a metal tag attached with a metal chain indicating the piping systems supplied.

Install a gas cock upstream of each gas pressure regulator. Where two (2) gas pressure regulators are installed in series in a single gas line, a manual valve is not required at the second regulator.

Install pressure relief or pressure limiting devices so they can be readily operated to determine if the valve is free; so they can be tested to determine the pressure at which they will operate; and examined for leakage when in the closed position. Pipe atmospheric vent to outdoors.

Solenoid valves shall be mounted with the solenoid in the vertical upright position only.

Electrical wiring for solenoid valves is specified in Division 26. Coordinate electrical requirements and connections.

Valves shall be installed with unions or other means to facilitate removal or repair without disassembly of connecting piping.

3.6 TERMINAL EQUIPMENT CONNECTIONS

Install gas cock upstream and within 6-feet of gas appliance. Install a union or flanged connection downstream from the gas cock to permit removal of controls.

Sediment Traps: Install a tee fitting with the bottom outlet plugged or capped as close to the inlet of the gas appliance as practical. Drip leg shall be a minimum of three (3) pipe diameters in length.

Flexible Hose Gas Connectors: U.L. Listed, for use connecting to vibrating equipment; corrugated Type 304 stainless steel flexible pipe with stainless steel braid.

3.7 ELECTRICAL BONDING AND GROUNDING

Install above ground portions of gas piping systems, upstream from equipment shutoff valves electrically continuous and bonded to a grounding electrode in accordance with NFPA 70 - "National Electrical Code".

Do not use gas piping as a grounding electrode.

Conform to NFPA 70 - "National Electrical Code," for electrical connections between wiring and electrically operated control devices.

3.8 FIELD QUALITY CONTROL

Piping Tests: Inspect, test, and purge natural gas systems in accordance with NFPA 54, and Local Utility requirements.

Test system before covering underground lines.

Submit written results of tests to Architect/Engineer.

END OF SECTION 23 11 23

SECTION 23 21 13
HYDRONIC PIPING

PART 1 - GENERAL

1.0 DESCRIPTION OF WORK

This section consists of furnishing and installing piping systems associated with heating, chilled, and condenser water systems.

1.1 QUALITY ASSURANCE

Comply with ASME B31.9 (Building Service Piping Code) for materials, products, installation, and testing.

Pipe and Fitting Manufacturer's Qualifications: Firms regularly engaged in manufacture of pipes and pipe fittings of types and sizes required, whose products have been in satisfactory use in similar service for not less than five (5) years.

Welder's Qualifications: All welders shall be qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications.

Before any welding is performed, the Contractor shall submit to the Architect/Engineer, a copy of the Manufacturer's Record of Welder or Welding Operator Qualification Tests and his Welding Procedure Specification together with the Procedure Qualification Record as required by Section IX of ASME Boiler and Pressure Vessel Code.

Each manufacturer or contractor shall be responsible for the quality of welding done by his organization and shall repair or replace any work not in accordance with these specifications.

Soldering and Brazing Procedures shall conform to ANSI B9.1 Standard Safety Code for Mechanical Refrigeration.

1.2 SUBMITTALS

Submit under provisions of Division 1.

Welding Certifications: Submit reports as required for piping work.

Brazing Certifications: Submit reports as required for piping work.

1.3 CLOSEOUT SUBMITTALS

Submit under provisions of Division 1. Additionally, submit the following information:

Valve Schedule for all Valves. For each valve, list valve designation number, valve type, size, location, and function.
Written report certifying leak testing.

PART 2 - PRODUCTS

2.0 MANUFACTURERS

Manufacturer: Subject to compliance with requirements, provide products by one of the following:

Air Vents (Manual and Automatic):

- Armstrong Machine Works.
- Bell & Gossett ITT; Fluid Handling Division
- Hoffman Specialty ITT; Fluid Handling Division
- Spirax Sarco

Air & Dirt Separators:

- Amtrol, Inc.
- Armstrong Pumps, Inc.
- Bell & Gossett ITT; Fluid Handling Division
- Taco, Inc.
- The John Wood Co.
- Spirotherm

Diaphragm-Type Compression Tanks:

- Amtrol, Inc.
- Armstrong Pumps, Inc.
- Bell and Gossett ITT; Fluid Handling Division
- Taco, Inc.
- The John Wood Co.

Pump Suction Diffusers:

- Amtrol, Inc.
- Armstrong Pumps, Inc.
- Bell & Gossett ITT; Fluid Handling Division
- Taco, Inc.
- Victaulic Company of America

Hydronic System Safety Relief Valves:

- Kunkle Valve Co., Inc.
- Lunkenheimer Co.
- Watts Regulator Co.
- Lonergan
- Keckley
- Bell & Gossett ITT; Fluid Handling Division

Pipe Escutcheons:

- Dearborn Brass
- Kohler
- Sioux Chief

Low Pressure Strainers:

- Armstrong Machine Works

Hoffman Specialty ITT; Fluid Handling Division
Metraflex Co.
R-P&C Valve; Division White Consolidated Industries, Inc.
Spirax Sarco
Trane Co.
Watts Regulator Co.

Pressure Seal Joint Fittings

Viega ProPress
Nibco Press System
Parker ZoomLock

Ball Valves

Nibco
Milwaukee
Watts
Grinnell

Globe Valves

Nibco
Milwaukee
Hammond
Stockham
Grinnell

Butterfly Valves

Keystone
Nibco
Milwaukee, “ML” Series
Stockham
Centerline
Watts
Grinnell
DeZurik

Check Valves

Nibco
Milwaukee
Stockham
Hammond
Grinnell

Safety Relief Valves

Amtrol
Bell & Gossett ITT; Fluid Handling Division
Kunkle Valve Co., Inc.
Lonergan
Lunkenheimer Co.
Watts

2.1 PIPING AND FITTINGS

General: Working pressure and temperature maximums, 125 psi and 250 degrees F; water service.

Copper Pipe: ASTM B88, hard-drawn copper tube, Type K for below ground lines and Type L for above ground lines.

Fittings:

Wrought copper solder joint fittings, ASME B16.22
Bronze pipe flanges/fittings, ANSI B16.24 (Class 150 and 300)
Mechanical Pressure-Seal Fittings as manufactured by Viega or Nibco.

Joining Material:

Solder:

ASTM B32, 95-5 tin-antimony, Grade 95TA
ASTM B32 (NSF), Silver-Tin-Copper Alloy

Brazing: AWS A5.8, for underground lines and where copper pipe is connected to brass.

Copper phosphorus-Bcup
Silver-Bag

Unions: ASME B16.22-95. Wrought copper solder joint, ground seat.
Dielectric Connections: Fittings having insulating material isolating joined dissimilar metals.

Waterway Fittings:

ASTM-A53 Xinc electroplated steel pipe casing with inert, non-corrosive thermoplastic lining (NSF/FDA listed).
Thread x thread ends 1/2-inch x 3-inch through 4-inch x 6-inch.
Listed by IAPMO/UPC and SBCC PST and ESI.
Dielectric unions are not an acceptable substitute for dielectric waterway fittings.

Steel Pipe:

ASTM A53, Schedule 40, black steel pipe. (Grade B, Type E, electric resistance welded) (Grade B, Type S or A106 high temperature; seamless)
Fittings:

Threaded: ASME B16.11, Class 125, cast iron. Standard pattern for threaded joints. Threads shall conform to ASME B1.20.1-83.
Flanged: ASME B16.5, Class 150, cast iron, raised ground face, bolt holes spot faced.

Gaskets: ANSI B16.21, full-faced for cast iron flanges, raised face for steel flanges.

Welded: ASTM B16.9, standard weight, seamless black steel, butt weld.

Unions: ASME B16.39-86, malleable-iron, Class 150, hexagonal stock, with ball-and-socket joints, metal-to-metal bronze seating surfaces; female threaded ends.
Dielectric Connections: Construct to isolate dissimilar metals, prevent galvanic action, and prevent corrosion.

Waterway Fittings:

ASTM-A53 Xinc electroplated steel pipe casing with inert, non-corrosive thermoplastic lining (NSF/FDA listed).
Thread x thread ends 1/2-inch x 3-inch through 4-inch x 6-inch.
Listed by IAPMO/UPC and SBCC PST and ESI.
Dielectric unions are not an acceptable substitute for dielectric waterway fittings.

Flanged Connection: Dielectric gasket and bolt kit.

Flexible Pipe Connectors: As specified in Section 23 05 48.

Copper Pressure-Seal-Joint Fittings, 2-inch and smaller only:

Fittings for 2-inch and Smaller: Wrought-copper fitting with EPDM-rubber, O-ring seal in each end.

2.2 VALVES

General:

Comply with MSS-92 1980 "Valve Users Manual".
Sizes: Provide valves of same size as upstream pipe size. Size control valves for required flow.

Extended Stems: Where insulation is indicated or specified, provide extended stems to allow full operation of the valve without interference by the insulation.

Bypass and Drain Connections: Comply with MSS SP-45.

End Connections: As specified in the individual valves specifications.

Threads: Comply with ANSI B2.1.
Flanges: Comply with ANSI B16.1 for cast iron, ANSI B16.5 for steel, and ANSI B16.24 for bronze.
Solder-Joint: Comply with ANSI B16.18. Where soldered end connections are used, use solder having a melting point below 840 degree F for gate, globe, and check valves and below 421 degree F for ball valves.

Ball Valves:

3-Inch and Smaller: MSS-SP-110, 150 psi SWP, 600 psi WOG, two-piece ASTM B584 cast bronze body, full port, chrome plated brass/bronze ball, TFE seats, anti-blowout stem separate packnut with adjustable stem packing, extended stem, and vinyl covered steel handle. Threaded or soldered end connections. Nibco T/S 585-70-EL.

Globe Valves:

2-1/2 Inch and Smaller: MSS SP-80, Class 150, ASTM B62 bronze body and bonnet, TFE seat disc and malleable iron or ductile iron hand wheel, union bonnet, non-asbestos packing, silicon bronze ASTM B371 or low-zinc alloy B-99 stem. Threaded or soldered end connections. Nibco T/S 235-4.
3-Inch and Larger: MSS SP-85, Class 125, ASTM A126, Class B cast iron body and bolted bonnet, cast bronze or cast iron disc and cast iron or malleable iron hand wheel, non-asbestos packing, bronze trimmed, OS&Y. Flanged end connection. Nibco F718-B.

Butterfly Valves:

4-Inch and Larger: MSS-SP-68, ASTM A126, Class B fully lugged iron body, ASTM B148 aluminum bronze disc, ASTM A582 416 stainless steel stem, RTFE seat liner, reinforced nylon bearings, (EPDM) (BUNA) bushing and NBR stem seals. ASTM class 200 WOG rating. (BUNA) (EPDM) liner, Rated for 200 psi bi-directional shutoff and 200 psi dead-end service with downstream piping removed. Provide extended neck for insulation. Sizes 4"–6" shall be lever operated with 10-position throttling plate; sizes 8-inch and larger shall have weatherproof gear operators.

Check Valves:

Swing Check Valve:

2-1/2 Inch and Smaller: MSS SP-80; Class 150 SWP, ASTM B62 bronze body and bonnet, horizontal swing design, Y-pattern, with TFE seat disc. Threaded or soldered end connections. Nibco T/S 433-Y
3-Inch and Larger: MSS SP-71; Class 125, ASTM A126 Class B cast iron body with bronze trim, non-asbestos gasket, horizontal swing, and flanged ends. Valve shall be capable of being refitted without removing from pipe. Nibco F918-B.

Drain Valve: Ball valve with threaded hose end and cap with chain. Nibco Model T/S-585-70-HC-EL

Safety Relief Valves:

Diaphragm operated, cast iron or brass body valve, with low inlet pressure check valve, inlet strainer removable without system shutdown and non-corrosive valve seat and stem; 125 psig working pressure and 250 degree maximum operating temperature. Valve designed, built, rated, and stamped in accordance with ASME Boiler and Pressure Vessel Code. Select valve to suit actual system pressure and BTU capacity. Factory set valve to relieve at 10 psi above operating pressure with field adjustment capabilities.

Pressure Reducing Valve: Diaphragm operated, cast iron or brass body, fill valve designed to maintain water pressure in a closed water system. Valve includes cleanable strainer, removable seat assembly, purge lever for quick filling, and built-in check valve. Adjustment range of 10 to 25 psig. Maximum operating temperature shall be 225 degrees F, maximum working pressure of 125 psig.

Backflow Preventer: As specified in Division 22.

2.3 PIPING ACCESSORIES

Manual Air Vent: Bronze body and nonferrous internal parts; 150 psig working pressure, 212 degree F operating temperature; manually coin operated and having discharge outlet connection and 1/8-inch NPT male connection.

Automatic Air Vent: Float type vent designed to vent automatically; bronze body and nonferrous internal parts. 150 psig working pressure, 240 degree F operating temperature. 1/4-Inch discharge connection and 1/2-inch inlet connection.

Drain Pans: Minimum 18 gauge stainless steel, reinforced to support weight of drain pan and water. Provide not less than 2-inch deep, with a 3/4-inch drain connection.

2.4 AIR & DIRT SEPARATORS

Combination air and dirt separator. Cast iron; constructed and labeled for minimum 175 psig water working pressure and 300 degree F operating temperature; integral weir designed to decelerate system flow and direct released air into compression tank; inline inlet and outlet connections; screwed connections up to and including 3-inch NPS; flanged connections for 4-inch NPS and above; threaded blowdown connection; sized as indicated for full system flow capacity.

Tangential inlet and outlet connections. Threaded blowdown connection sized for full system flow. 1/4-Inch connection located at top of air separator for expansion tank connection. Factory applied enamel finish. Provide screwed connections up to and including 3-inch NPS; flanged connections for 4-inch NPS and above.

2.5 EXPANSION TANKS

Diaphragm Compression Tank Type: Welded steel tank suitable for 125 psig working pressure, 350 degrees maximum operating temperature; constructed, tested, and labeled in accordance with ASME Pressure Vessel Code. Flexible diaphragm separates air charge from system water. Include taps for pressure gauge, air charge fitting, and drain. Diaphragm material shall be chemically inert to Propylene Glycol. Support vertical tanks with steel legs or base; support horizontal tanks with steel saddles. Tank, with taps and supports, shall be constructed, tested, and labeled in accordance with ASME Pressure Vessel Code, Section VIII, Division 1.

2.6 PUMP SUCTION DIFFUSERS

Pump Suction Diffusers: Cast iron body, with threaded connections for 2-inch and smaller, flanged connections for 2-1/2 inch and larger; 175 psig working pressure, 300 degree F maximum operating temperature; and complete with the following features:

Inlet vanes with length 1-1/2 times pump suction diameter or greater.
Cylinder strainer with 3/16-inch diameter openings with total free area equal to or greater than five (5) times cross-sectional area of pump suction, designed to withstand pressure differential equal to pump shutoff head.
Disposable fine mesh strainer to fit over cylinder strainer (start-up strainer).
Permanent magnet, located in flow stream, removable for cleaning.
Adjustable foot support, designed to carry weight of suction piping.
Blowdown tapping in bottom; gauge tapping in side.
Inlet vanes with length 2-1/2 times pump section diameter or greater.

2.7 STRAINERS

Low Pressure Pipeline Strainers

General: Provide strainers full line size of connecting piping, with ends matching piping system materials. Select strainers for 125 psi working pressure, with Type 304 stainless steel screens, with 3/64-inch perforations at 233 per square inch.
Threaded Ends, 2-Inch and Smaller: Cast iron body, screwed screen retainer with centered blowdown fitted with pipe plug.
Threaded Ends, 2-1/2 Inch and Larger: Cast iron body, bolted screen retainer with off-center blowdown fitted with pipe plug.

Flanged Ends, 2-1/2 Inch and Larger: Cast iron body, bolted screen retainer with off-center blowdown fitted with pipe plug.
Butt Welded Ends, 2-1/2 Inch and Larger: Schedule 40 cast carbon steel body, bolted screen retainer with off-center blowdown fitted with pipe plug.

PART 3 - EXECUTION

3.0 PIPE APPLICATIONS

2-Inches and Smaller:

Black Steel: Steel pipe with threaded joints and fittings.

Copper Pipe:

Install Type L copper pipe with wrought copper fittings and solder joints, above ground, within building.
Install Type K copper pipe with wrought copper fittings and brazed alloy joints below ground.
Contractor Option: Pressure-Seal Fittings with Type L pipe above ground within the building.

2-1/2 Inches and Larger: Install black steel pipe.

Welded and Flanged Joints: Install welded fittings on pipe 2-1/2 inches and larger.

3.1 PIPING INSTALLATION, GENERAL

Arrange piping in horizontal groups, each group to be in one plane. Maintain indicated slope.

Conceal pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors.

Install piping tight to slabs, beams, joists, columns, walls, and other permanent elements of the building. Install piping parallel to permanent elements of building. Provide space to permit insulation applications, with 1-inch clearance outside insulation. Provide 2-inch space above removable ceiling panels to allow for panel removal.

Fire and Smoke Wall Penetrations: Maintain the fire and smoke rated integrity where pipes pass through fire and smoke rated walls, partitions, ceilings, and floors. Refer to Section 23 05 00.

Sloping, Air Venting, and Draining:

Install piping true to line and grade, and free of traps and air pockets. Install piping level except for gravity flow systems such as condenser water and condensate drain piping.
Connect branch piping to bottom of mains, except for up-feed risers, which shall have take-off on top of main.
Install manual air vents at high points in hydronic piping systems and at all coils. Provide 1/4-inch copper, 180 degree bend pipe to discharge vented water into can.
Install automatic air vent on air separator and where shown. Provide valved inlet and route discharge pipe to floor drain.
Install drain valves with hose adapters at low points in mains, risers, and branch lines.
Drain consists of a tee fitting, 3/4-inch ball valve, and short 3/4-inch threaded nipple and cap.

Fittings: Standard manufactured fittings. Field fabricated fittings and bushings are prohibited on all piping.

Make reductions in pipe sizes using eccentric reducer fitting installed with the level side up.

Unions: Install unions in pipes 2-inch and smaller, adjacent to each valve, at final connections of each piece of equipment and elsewhere to permit alterations and repairs. Install dielectric waterway fittings to join dissimilar metals.

Flanges: Install flanges on valves and equipment having 2-1/2 inch and larger connections.

Joints:

Threaded Joints: Apply Teflon tape to male equipment threads. Do not use pipe with threads that are corroded or damaged.
Soldered Joints: Comply with AWS Soldering Manual-98.

Keep openings in piping closed during construction to prevent entrance of foreign matter.

Install flexible connectors at inlet and discharge connections to base-mounted pumps and other vibration producing equipment.

Electrical Equipment Spaces: Do not run piping through transformer vaults and other electrical spaces.

Pressure-Seal Fittings shall have EPDM seal material compatible with glycol, chemical treatment, corrosion inhibiters, etc.

Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.

3.2 VALVES

Field check valves for packing and lubricant. Replace leaking packing. Service valves with lubricant for smooth and proper operation before placing in service.

Install valves accessible from floor level, located for easy access.

Install valves in horizontal piping with stem at or above center of pipe. Install valves in position to allow full stem movement. Provide operating handles for valves and cocks without integral operators.

Provide extended valve stems where insulation is specified.

Provide separate support where necessary.

Where soldered end connections are used for valves, use solder having a melting point below 840 degrees F for gate, globe, and check valves; below 421 degrees F for ball valves.

Provide valves same size as line size.

Provide drain valves and hose adapters at strainers for blowoff; same size as strainer blowoff connection.

Provide mechanical actuators with chain operators where valves 2-1/2 inches and larger are mounted more than 6-feet above the floor. Extend chains to elevation of 5-feet above floor.

Check Valves:

Install check valves for proper direction of flow as follows:

Swing Check Valve: Horizontal position with hinge pin level.

Valve End Selection: Select valves with the following ends or types of pipe/tube connections:

Copper Tube Size 2-Inch and Smaller: Solder ends.
Steel Pipe Sizes 2-Inch and Smaller: Threaded end.
Steel Pipe Sizes 2-1/2 Inch and Larger: Flanged end.
At all piping hot taps provide a gate valve with the hot tap and a butterfly valve for shutoff service. Hot taps shall be provided only where approved by the Engineer.

Valve Application: Install valves in accordance with the following table.

SERVICE	VALVE TYPE
Hydronic Isolation; 2" and Smaller	Ball Valve
Hydronic Isolation; 2-1/2" and Larger	Butterfly Valve
Hydronic Throttling or Bypass Valve; All Sizes	Globe Valve
Hydronic Balancing Valve; 2" and Smaller	Calibrated Balancing Valve
Hydronic Balancing Valve; 2-1/2" and Larger	Calibrated Balancing Valve
Hydronic Pump Discharge Check Valves; 2" & Smaller	Swing Check
Hydronic Pump Discharge Check Valve; 2-1/2" & Larger	SwingCheck Valve

3.3 EQUIPMENT PIPING

Provide combination balancing and shutoff valves to regulate water flow through piping, coils, and at other equipment and piping where shown or required for proportioning flow.

Install automatic fill valve in cold water make-up to boilers and manual fill valve for chillers. Install three-valve bypass with globe valve around automatic fill valve for quick filling system. Install backflow preventer upstream of fill valve and bypass.

3.4 DRAIN PANS

Install drain pan under the entire length of any piping, including valves, joints, and fittings installed over motor, motor starter, switch gear, transformer, or other electrical equipment and under all piping located anywhere in any transformer vault, electrical switchboard room, and telephone equipment room. Pipe drain connection to discharge where shown or at nearest floor drain.

3.5 TESTING

General: Provide temporary equipment for testing including pump and gauges. Test before insulation is installed. Test piping to be concealed prior to permanent enclosure.

Provide the Engineer a minimum of twenty-four hours notice of dates when acceptance test will be conducted. Conduct tests in presence of representative of agency having jurisdiction.

Test piping systems using ambient temperature water, except where there is risk of damage due to freezing. Engineer approval is required prior to testing if other than hydrostatic tests are used.

Use vents installed at high points in the direction of flow, in the system to release trapped air while filling the system. Use drains installed at low points for complete removal of the liquid.

Examine system to see that equipment and parts that cannot withstand test pressures are properly isolated.

System Tests:

Hydrostatic Test: Pressurize the system to 100 psig or 1.5 times the design pressure, whichever is greater. Maintain pressure until the entire system has been inspected for leaks, but in no case for a time period of less than four (4) hours.

Compressed Air or Nitrogen Test: Compressed air tests may be substituted for hydrostatic tests only when ambient conditions prohibit safe use of hydrostatic testing and must be reviewed by the Engineer prior to any testing. For tests of this type, subject the piping system to the gas pressure indicated for that specific system. Maintain the test pressure for the duration of a soapy water test of each joint.

Maintain test pressure until the entire system has been inspected for leaks, but in no case less than four hours. Examine all piping, joints, and connections for leakage.

Repair failed piping sections by disassembly and re-installation, using new materials to extent required to overcome leakage. Do not use chemicals, stop-leak compounds, mastics, or other temporary repair methods.

Drain test water after testing and repair work has been completed.

Prepare written report of testing, indicating locations of leaks corrected, method used to correct leaks, number of tests required, and certification that system is leak free. Provide three (3) copies of test results.

3.6 ADJUSTING AND CLEANING

Flush system with clean water. Remove, clean, and replace strainer screens.

After cleaning and flushing but before balancing, remove disposable fine mesh strainers in pump suction diffusers.

3.7 HYDRONIC SPECIALTIES INSTALLATION

Manual Air Vent: Provide manual air vents at all high points and drops in the direction of flow, of all mains and risers of the hydronic systems, at heat transfer coils, radiation and elsewhere shown and as required for system air venting.

Provide enlarged air collection standpipe where large air quantities can accumulate.

Provide a 1/2-inch ball valve, reducer and pipe nipple installed between hydronic system pipe and manual air vent.

Provide 1/4-inch discharge pipe from manual air vent discharge connection to nearest floor drain or as indicated.

Air & Dirt Separator: Install air & dirt separators in hydronic systems pump suction lines. Run piping to compression tank with 1/4-inch per foot (2 percent) upward slope towards tank. Install drain valve on units 2-inch and larger.

Pump Suction Diffuser: Install pump suction diffusers on hydronic systems pump suction inlet, adjust foot support to carry weight of suction piping. Install nipple and ball valve in blowdown connection.

Diaphragm-Type Compression Tank: Install diaphragm-type compression tanks in hydronic systems on floor as indicated. Vent and purge air from hydronic system, charge tank with proper air charge to suit system design requirements.

Support tank as detailed on the drawings. Provide support from the floor or structure adequate to carry twice the weight of the tank, piping connections, fittings, and weight of water assuming a full tank of water. Do not overload building components and structural members.

Strainers: Install strainers full size of pipeline, in accordance with manufacturer's installation instructions. Install pipe nipple and shutoff full port ball valve with 3/4-inch hose end and brass cap with hose "washer" and chain in strainer blowdown connection. Where indicated, provide drain line from shutoff valve to plumbing drain, full size of blowdown connection.

Provide strainers in supply line ahead of the following equipment, and elsewhere as indicated.

Pumps
Control Valves
Pressure Reducing Valves

3.8 TRAINING

Provide two (2) hours of instruction on hydronic systems. Include following items as a minimum:

Location of automatic and manual air vents.
Location of strainers and blow down valves.
Location of safety and relief valves.
System drain valves.
System fill and associated devices.
Expansion tank and air separator.

END OF SECTION 23 21 13

SECTION 23 21 23

HVAC PUMPS

PART 1 - GENERAL

1.0 DESCRIPTION OF WORK

Extent of HVAC Pumps Work required by this section is indicated on drawings and schedules, and by requirements of this section.

Types of Pumps specified in this section include the following:

In-Line Circulator
Frame-Mounted End Suction

Pumps furnished as part of factory-fabricated equipment are specified as part of equipment assembly in other Division 23 sections.

Refer to other Division 23 sections for other work; not work of this section.

Refer to Division 26 sections for the following work; not work of this section.

Power supply wiring from power source to power connection on pumps. This Contractor shall include disconnects, and required electrical devices, except where specified as furnished, or factory-installed, by manufacturer.
Interlock wiring between pumps; and between pumps and field-installed control devices.

Interlock wiring specified as factory-installed is work of this section.

Provide the following Electrical Work as work of this section, complying with requirements of Division 26 sections:

Control Wiring between field-installed controls, indicating devices, and pump control panels.

Control Wiring specified as work of Division 23 for Automatic Temperature Controls is work of that section.

1.1 QUALITY ASSURANCE

Manufacturer's Qualifications: Firms regularly engaged in manufacture of general-use centrifugal pumps with characteristics, sizes and capacities required, whose products have been in satisfactory use in similar service for not less than five (5) years.

Codes and Standards:

HI Compliance: Design, manufacture, and install HVAC pumps in accordance with HI "Hydraulic Institute Standards".
UL Compliance: Design, manufacture, and install HVAC pumps in accordance with UL 778 "Motor Operated Water Pumps".
UL and NEMA Compliance: Provide electric motors and components which are listed and labeled by Underwriters Laboratories and comply with NEMA Standards.

Certification, Pump Performance: Provide pumps whose performances, under specified operating conditions, are certified by manufacturer.

1.2 SUBMITTALS

Product Data: Submit manufacturer's pump specifications, installation and start-up instructions, and current accurate pump characteristic performance curves with selection points clearly indicated.

Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loadings, required clearances, and methods of assembly of components.

Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to HVAC pumps. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

Record Drawings: At project closeout, submit record drawings of installed systems products in accordance with requirements of Division 1.

Maintenance Data: Submit maintenance data and parts lists for each type of pump, control, and accessory; including "trouble-shooting" maintenance guide. Include this data, product data, shop drawings, and wiring diagrams in maintenance manual; in accordance with requirements of Division 1.

1.3 DELIVERY, STORAGE, AND HANDLING

Handle HVAC pumps and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged HVAC pumps or components; replace with new.

Store HVAC pumps and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.

Comply with Manufacturer's rigging and installation instructions for unloading HVAC pumps, and moving them to final location.

PART 2 - PRODUCTS

2.0 MANUFACTURERS

Manufacturer: Subject to compliance with requirements, provide products by one of the following:

In-Line Circulator Pumps:

Armstrong Pumps, Inc.
Aurora
Bell & Gossett ITT; Fluid Handling Division
Taco
Paco

Frame-Mounted End Suction Pumps:

Armstrong Pumps, Inc.
Aurora
Bell & Gossett ITT; Fluid Handling Division
Taco
Paco

2.1 PUMPS

General: Provide factory-tested pumps, thoroughly cleaned, and painted with one (1) coat of machinery enamel prior to shipment. Type, size, and capacity of each pump is listed in pump schedule. Provide pumps of same type by same manufacturer.

Pump motor shall be sized so as not to be overloaded at any point along impeller curve for specified performance.

All pump couplers shall be suitable for both constant speed and variable speed operation.

2.2 IN-LINE CIRCULATOR PUMPS

General: Provide bronze fitted in-line circulator pumps where indicated, and of capacities as scheduled.

Type: Horizontal mount, vertical split case, oil-lubricated, designed for 125 psi working pressure, and 225 degree F (107 degree C) continuous water temperature.

Body: Cast iron, with flanged suction and discharge and gauge tappings.

Shaft: Hardened alloy steel.

Bearings: Oil-lubricated bronze journal bearings.

Seal: Mechanical, with carbon seal ring and ceramic seat.

Motor: Pump motor shall be non-overloading at any point on pump curve and meet requirements of Section 23 05 13.

Coupling: Self-aligning, flexible coupling.

Impeller: Brass or Bronze enclosed type, hydraulically and dynamically balanced, and keyed to shaft.

2.3 FRAME-MOUNTED END SUCTION PUMPS

General: Provide frame-mounted bronze fitted end suction pumps where indicated, and of capacities and having characteristics as scheduled.

Type: Horizontal mount, single stage, vertical split case, flexible coupling, base mounted, designed for 175 psi working pressure.

Casing: Cast iron, 125 psi ANSI flanges, tappings for gauge and drain connections.

Shaft: Steel with replaceable shaft sleeve.

Bearings: Regreaseable ball bearings.

Seal: Mechanical, with carbon seal ring and ceramic seat.

Motor: Pump motor shall be non-overloading at any point on pump curve and meet requirements of Section 23 05 13.

Impeller: Bronze enclosed type, hydraulically and dynamically balanced, keyed to shaft and secured with locking screw. Assembly components shall be 304 stainless steel.

Baseplate: Structural steel with welded cross members, and open grouting area.

Coupling: Flexible, capable of absorbing torsional vibration, equipped with coupling guard.

PART 3 - EXECUTION

3.0 INSPECTION

Examine areas and conditions under which HVAC pumps are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.1 INSTALLATION OF PUMPS

General: Install HVAC pumps where indicated, in accordance with manufacturer's published installation instructions, complying with recognized industry practices to ensure that HVAC pumps comply with requirements and serve intended purposes.

Access: Provide access space around HVAC pumps for service as indicated, but in no case less than that recommended by manufacturer.

Support: Install base-mounted pumps with inertia base on minimum of 4-inch high concrete base equal or greater than three (3) times total weight of pump and motor, with anchor bolts poured in place. Set and level pump, grout under pump base with non-shrink grout.

Inertia base required for pumps on the second floor only.
Install in-line pumps, supported from piping system.

Support: Refer to Division 23 section "Vibration Control" for support and mounting requirements of HVAC pumps.

Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.

Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment Installer.

Piping Connections: Provide system return connection to inlet strainer with valved bypass to drain. Provide pump discharge connections with check valve, shutoff valve, and balancing valve for each pump.

3.2 ADJUSTING AND CLEANING

Alignment: Adjust shafts of all motors and pumps within recommended tolerances by manufacturer, and in presence of manufacturer's service representative.

Start-Up: Lubricate pumps before start-up. Start-up in accordance with manufacturer's instructions.

Refer to Division 23, Section 23 05 93, for pump system balancing; not work of this section.

Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION 23 21 23

SECTION 23 25 05
GLYCOL SYSTEMS

PART 1 - GENERAL

1.0 DESCRIPTION OF WORK

Automatic glycol feed systems and inhibited propylene glycol solutions.

1.1 QUALITY ASSURANCE

Manufacturer's Qualifications: Firms regularly engaged in manufacture of glycol systems of types and sizes required, whose products have been in satisfactory use in similar service for not less than five (5) years.

Codes and Standards: Provide glycol system components and materials to meet all Local and National Codes and Standards.

Provide one (1) year manufacturer's warranty.

1.2 SUBMITTALS

Product Data: Submit manufacturer's technical product data, including installation instructions and dimensioned drawings.

Maintenance Data: Submit maintenance data and spare parts lists. Include this data, product data, and shop drawings in maintenance manual in accordance with requirements of Division 1.

1.3 CLOSEOUT SUBMITTALS

Submit glycol solution strength test results.

PART 2 - PRODUCTS

2.0 AUTOMATIC GLYCOL MAKE-UP SYSTEM

General: Provide factory assembled and leak tested glycol feed system with the following components.

Tank: 50 Gallon polyethylene, removable cover, and required system connections. Support with four-leg steel stand with four (4) bolt pads painted with oxide primer and enamel finish.

Pump: Bronze positive displacement rotary gear or turbine type, 1.5 GPM minimum flow rate at 100 psi TDH, 1/3 HP ODP motor, 120/1/60.

Control: System automatically injects a glycol/water solution into hydronic loop based on a drop in pressure in the loop. System shall be either pressure switch and pump, or pressure regulating valve in combination with diaphragm tank pressure switch and pump. Low level cut-off interlocked with pump.

Pressure Switch: Field adjustable, 10-20 psi pressure range, factory set at 12 psi.

Pressure Relief Valve: Prevents over-pressure and relieves back to tank.

Pressure Gauge with isolation valve on discharge piping.

Low Level Switch: Mounted on solution tank.

Suction Piping: 1/2-Inch rubber hose or PVC piping with ball valve and Y strainer.

Discharge Piping: 1/2-Inch steel piping with MI fittings or rigid copper piping with brass fittings. Provide pressure switch, ball valve, check valve, and relief valve on the pump discharge.

Control Panel: Minimum NEMA 12 enclosure, HOA with running light and magnetic starter for feed pump, alarm light and audible alarm and dry contacts for BAS connection for low level, 8-foot power cord with grounded plug, all wiring routed in conduit.

Provide an extra 50 gallon drum of propylene glycol with transfer pump. Hand-operated rotary type, 8'-0" long, 3/4-inch hose with 3/4-inch non-sparking nozzle, 1-inch telescoping suction pipe, adaptor with 2-inch thread.

Acceptable Manufacturers:

John Woods Company
Calcium Control
Sage Industries, Inc.
Axiom

2.1 GLYCOL SOLUTION

Provide glycol solutions for the systems specified in the following table.

System	Percent Volume of Propylene Glycol	Burst Protection (degree F)	Freeze Protection (degree F)
Chilled Water	30%	-15	9
Snowmelt Heating Water	30%	-40	-7

Glycol Fluid: 95.5 Percent propylene glycol and 4.5 percent inhibitors and water, water white in color, operating temperature range –50 degree F to 250 degree F.

Acceptable Manufacturers:

DOW DOWFROST

PART 3 - EXECUTION

3.0 INSTALLATION

Provide necessary piping for a complete installation of glycol make-up system.

Thoroughly clean and flush hydronic system before adding propylene glycol solution.

Field adjust pressure switch to match system fill pressure.

Once the hydronic system has been filled, refill the storage tank on the automatic glycol make-up system with the appropriate concentration of glycol and water.

Perform glycol solution test and provide report to Owner.

Provide one (1) year service agreement to refill the storage tank on the automatic glycol make-up system during the first year and perform glycol concentration test at the end of the first year of operation.

END OF SECTION 23 25 05

SECTION 23 31 13
METAL DUCTWORK

PART 1 - GENERAL

1.0 DESCRIPTION OF WORK

Extent of Metal Ductwork is indicated on the drawings, schedules, and by requirements of this section.

Ductwork Construction Table

Service	Type	Pressure Class	Insulation	Seal Class
Supply Air between Air Handling Unit and Terminal Air Box	Galvanized steel, rectangular	+4"	Lined	B
Supply Air between Air Handling Unit and Terminal Air Box	Galvanized steel, Spiral seam round	+4"	Wrapped	B
Supply Air between Terminal Air Box and Air Devices (concealed)	Galvanized steel, rectangular	+1"	Lined	C
Supply Air between Terminal Air Box and Air Devices (concealed)	Galvanized steel, Spiral seam round	+1"	Wrapped	C
Supply Air between Terminal Air Box and Air Devices (exposed)	Spiral seam round galvanized steel suitable for painted finish	+1"	None	C
Return Air	Galvanized steel, Spiral seam round or rectangular	-3"	Lined	B
Air Handling Unit Exhaust and Outside Air	Rectangular galvanized steel	+3"	Wrapped	B
Exterior Supply and Return	Galvanized steel spiral seam round or rectangular	3"	Lined	B
General Building Exhaust	Galvanized steel spiral seam round or rectangular	-3"	None	B
Transfer Duct	Rectangular galvanized steel	+1"	Lined	C
Return Grille Sound Boot	Rectangular galvanized steel	+1"	Lined	C
Shower Room Exhaust	Aluminum construction, spiral seam round or rectangular with silicone sealant, install with no seams longitudinally along bottom	-3"	None	B

1.1 QUALITY ASSURANCE

Manufacturer's Qualifications: Firms regularly engaged in manufacture of metal ductwork products of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than five (5) years.

Installer's Qualifications: Firm with at least three (3) years of successful installation experience on projects with metal ductwork systems similar to that required for project.

References to SMACNA, ASHRAE and NFPA are minimum requirements, the Contractor shall fabricate, construct, install, seal all ductwork as described in this specification and as shown on the drawings, in addition to these minimum standard references.

Codes and Standards:

SMACNA "HVAC Duct Construction Standards, Metal and Flexible".
SMACNA "HVAC Air Duct Leakage Test Manual".
ASHRAE "Systems and Equipment Handbook", Chapter 16, Duct Construction.
NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems".

1.2 SUBMITTALS

Product Data: Submit manufacturer's technical product data and installation instructions.

Shop Drawings: Submit scale drawings of ductwork and fittings including, but not limited to, duct sizes, locations, elevations, and slopes of horizontal runs, wall and floor penetrations, and connections. Show interface and spatial relationship between ductwork and equipment. Show modifications of indicated requirements, made to conform to local shop practice, and how those modifications ensure that free area, materials, and rigidity are not reduced. Refer also to specification for 3D coordination drawing requirement.

Record Drawings: At project closeout, submit record drawings of installed systems, in accordance with requirements of Divisions 1 and 23.

Maintenance Data: Submit maintenance data and parts lists for metal ductwork materials and products. Include maintenance data and shop drawings in maintenance manual.

1.3 DELIVERY, STORAGE, AND HANDLING

Protection: Protect ductwork and accessories from damage during shipping, storage, and handling. Prevent dirt and moisture from entering ducts and fittings.

Storage: Where possible, store ductwork inside. Where necessary to store outside, enclose with waterproof wrapping.

PART 2 - PRODUCTS

2.0 MANUFACTURERS

Manufacturers: Subject to compliance with requirements, provide products by one of the following:

Rectangular Duct Liner:

CertainTeed Corp.
Johns-Manville Products Corp.
Knauf Fiberglass
Manson
Owens-Corning Fiberglas Corp.

Round Duct Liner:

Johns-Manville Products Corp.

Flexible Ducts:

Flexmaster
Thermaflex
Ominair
JP Lamborn Co.

Spin-In Fittings:

Flexmaster
Thermaflex
Ominair
Hercules Industries

Factory-Fabricated Round Ductwork

Semco Mfg., Inc.
Hercules Industries
United Sheet Metal Division, United McGill Corp.
Sheet Metal Products Co.
Spiral Pipe of Texas, Inc.
AccuDuct

2.1 DUCTWORK MATERIALS

Exposed Ductwork: Where ductwork is exposed to view in occupied spaces, provide mill phosphatized finish that is free from visual imperfections, including pitting, seam marks, roller marks, stains, dents, discolorations, and other imperfections, including those that would impair painting.

Galvanized Steel Sheet: Except as otherwise indicated, fabricate ductwork from galvanized sheet steel complying with ASTM A 527, lockforming quality; with G 90 zinc coating in accordance with ASTM A 525.

Stainless Steel Sheet: ASTM A 167; Type 304 or 316; with No. 4 finish where exposed to view in occupied spaces, No. 1 finish elsewhere. Protect finished surfaces with factory applied adhesive protective paper, maintained through fabrication and installation.

Aluminum Sheet: ASTM B 209, Alloy 3003, Temper H14.

Steel: Fabricate ductwork serving Type 1 hoods using steel having a minimum thickness of 0.0058” (16 gauge) or stainless steel not less than 0.045” (No. 18 gage) in thickness.

2.2 MISCELLANEOUS DUCTWORK MATERIALS

General: Provide materials of types and sizes required to comply with ductwork system requirements.

Fittings: Provide radius type fittings fabricated of multiple sections with maximum 15-degree change of direction per section. Unless specifically detailed otherwise, use 45-degree laterals and 45-degree elbows for branch takeoff connections. Where 90-degree branches are indicated, provide conical type tees.

Rectangular Duct Liner: ASTM C1071 fiberglass duct liner with UL approved 25/50 flame/ smoke development. Factory applied edge and air surface coating of acrylic treated with EPA registered ASTM G21 and G22 anti-microbial agent.

K Value: ASTM C 518, 0.25 at 75 degree F mean temperature.
Noise Reduction Coefficient: ASTM C 423, 0.70 based on Type A Mounting.
Maximum Velocity: 5000 fpm.
Adhesive: Meeting ASTM C919.
Fasteners: Duct liner galvanized steel pins, welded or mechanically fastened.
Interior Ductwork: 1-Inch thick.
Exterior Ductwork: 3-Inch thick (R-12 min.).

Round Duct Liner: 1-Inch thick rigid preformed round liner with air surface coated with acrylic coating treated with EPA registered ASTM G 21 and G22anti-microbial agent and UL approved 25/50 flame/smoke development.

K Value: ASTM C 518, 0.23 at 75 degree F mean temperature.
Noise Reduction Coefficient: ASTM C 423, 0.70 based on Type A mounting.
Maximum Velocity: 5,000 fpm.

Duct Sealant: UL 181 Listed, Class 1, flame spread 0, fuel contributed 0, smoke developed 0, water-based sealant, non-toxic, non-combustible, and non-flammable. Non-hardening, non-migrating mastic or liquid elastic sealant, type applicable for fabrication/installation detail, as compounded and recommended by manufacturer specifically for sealing joints and seams in ductwork. Sealant shall meet LEED IEQ 4.1 (meeting VOC tables published by SCAQMD #1168 Criteria for Low Emitting Materials.

Service temperature -20°F to 200°F.
Mold and Mildew resistant
VOC: Maximum 50g/l (less water and exempt solvents).

Adhesives: Water based; suitable for bonding fibrous duct wrap and duct liner insulation to galvanized duct work. Install evenly and secure with mechanical fasteners in accordance with SMACNA HVAC Duct Construction Standard for Metal and Flexible Duct. Adhesive shall meet LEED EQ 4.1 (SCAQMD Rule #1168 VOC tables) low emitting materials. Fiberglass adhesives shall meet California Dept. of Public Health (CDPH) Standard Method Ver. 1.1, 2010 Small Scale Chamber Test for VOC's for CA Specification 01350.

Non-Oxidizing
Meets FDA, USDA and EPA Standards
Meets Requirements of UL 723, ASTM E-84 NFPA 90A & 90B and ASTM C-916 Type II.

Ductwork Support Materials: Except as otherwise indicated, provide hot-dipped galvanized steel fasteners, anchors, rods, straps, trim and angles for support of ductwork.

For aluminum ductwork, provide aluminum support materials except where materials are electrolytically separated from ductwork.

Flexible Ducts: Flexible air ducts shall be listed under UL-181 standards as Class I Air Duct Material and shall comply with NFPA Standards 90A and 90B. Minimum operating pressure rating shall be 6-inch w.c. through a temperature range of -20 degree to 150 degree F; maximum working velocity rating shall be 4,000 fpm. Contractor shall assume responsibility for supplying material approved by the Authority Having Jurisdiction.

All insulated flexible ducts shall be constructed on an all metal, CPE, or aluminum laminate inner core, fiberglass insulation with minimum R-Valve of 4.0 or greater and an outer jacket made exclusively of fire retardant reinforced material.

Non-insulated flexible ducts shall be constructed from dead soft aluminum sheet, spiral corrugated, or aluminum construction over a steel spring helix.

Spin-in Fittings: Provide spin-in fittings between flexible and round sheet metal duct takeoffs and air devices from main ducts. Spin-in fittings shall include bell mouth and butterfly type manual volume damper with regulator and locking device.

Rectangular-to-Round Taps: Where the round branch take-off will not permit a spin-in fitting, provide a rectangular to round tap. Include manual volume damper with locking devices.

All fasteners and hardware for stainless steel ductwork shall be made of stainless steel.

2.3 FABRICATION

Fabricate ductwork of gauges and reinforcement complying with SMACNA "HVAC Duct Construction Standards" and ASHRAE "Systems and Equipment Handbook", Chapter 16, Duct Construction.

Elbows – Rectangular

For low pressure systems use 1.0 radius smooth elbows. (From focal point to centerline of duct).
For medium pressure systems use 1.5 radius smooth elbows. (From focal point to centerline of duct).
If radius elbows cannot fit, use mitered elbows with turning vanes.

Limit angular tapers to 30 degree for contracting tapers and 20 degree for expanding tapers.

2.4 FACTORY-FABRICATED ROUND DUCTWORK (2-Inch Pressure Class and Less)

Material: Galvanized sheet steel complying with ASTM A 527, lockforming quality, with ASTM A 525, G90 zinc coating, mill phosphatized.

Gauge: 28 Gauge minimum for round and oval ducts and fittings, 4-inch through 24-inch diameter.

Elbows: One-piece construction for 90 degree and 45 degree elbows 14-inch and smaller. Provide multiple gore construction for larger diameters with standing seam circumferential joint. Elbow radius shall be a minimum of 1.5 radius.

Divided Flow Fittings: 90 Degree tees, constructed with saddle tap spot welded and bonded to duct fitting body.

2.5 FACTORY-FABRICATED ROUND DUCTWORK (3-Inch Pressure Class and Above)

General: Provide factory-fabricated duct and fittings. All fittings shall be low loss conical type.

Round Ductwork: Construct of galvanized sheet steel complying with ASTM A 527 by the following methods and in minimum gauges listed.

Diameter	Minimum Gauge	Method of Manufacture
3" to 14"	26	Spiral Lockseam
15" to 26"	24	Spiral Lockseam
27" to 36"	22	Spiral Lockseam
37" to 50"	20	Spiral Lockseam
51" to 60"	18	Spiral Lockseam
Over 60"	16	Longitudinal Seam

Provide locked seams for spiral duct; fusion-welded butt seam for longitudinal seam duct. Provide internal stiffener rings and external reinforcement as required to meet operating static pressures scheduled on drawings.
Fittings and Couplings: Construct of minimum gauges listed. Provide continuous welds along seams.

Diameter	Minimum Gauge
3" to 36"	20
38" to 50"	18
Over 50"	16

Fittings and Couplings: Construct of minimum gauges listed. Provide continuous weld along seams.

Maximum Width	Minimum Gauge
Under 37"	20
37" to 50"	18
Over 50"	16

Internally Insulated Duct and Fittings: Construct with outer pressure shell, 1-inch thick insulation layer, and perforated inner liner. Construct shell and liner of galvanized sheet steel complying with ASTM A 527, of spiral lockseam construction, use longitudinal seam for over 59-inches, in minimum gauges listed.

Nominal Duct Diameter	Outer Shell	Inner Liner
3" to 12"	26 gauge	24 gauge
13" to 24"	24 gauge	24 gauge
25" to 34"	22 gauge	24 gauge
35" to 48"	20 gauge	24 gauge
49" to 58"	18 gauge	24 gauge
Over 59"	16 gauge	20 gauge

Fittings and Couplings: Construct of minimum gauges listed. Provide continuous weld along seams of outer shell.

Nominal Duct Diameter	Outer Shell	Inner Liner
3" to 34"	20 gauge	20 gauge
36" to 48"	18 gauge	20 gauge
Over 48"	16 gauge	20 gauge

Inner Liner: Perforate with 3/32-inch holes for 22 percent open area. Provide metal spacers welded in position to maintain spacing and concentricity.

PART 3 - EXECUTION

3.0 INSPECTION

General: Examine areas and conditions under which metal ductwork is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.1 INSTALLATION OF METAL DUCTWORK

General: Assemble and install ductwork in accordance with recognized industry practices that will achieve airtight and noiseless (no objectionable noise) systems. Install each run with minimum number of joints. Align ductwork accurately at connections, within 1/8-inch misalignment tolerance and with internal surfaces smooth. Support ducts rigidly with suitable ties, braces, hangers, and anchors of type that will hold ducts true-to-shape and prevent buckling, popping or compressing. Support vertical ducts at every floor.

Inserts: Install concrete inserts for support of ductwork in coordination with formwork, as required to avoid delays in work.

Routing: Locate ductwork runs vertically and horizontally and avoid diagonal runs wherever possible. Locate runs as indicated by drawings, details and notations or, if not otherwise indicated, run ductwork in shortest route which does not obstruct useable space or block access for servicing building and its equipment. Hold ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building. Limit clearance to 1/2-inch where furring is shown for enclosure or concealment of ducts, but allow for insulation thickness, if any. Where possible, locate insulated ductwork for 1-inch clearance outside of insulation. Wherever possible in finished and occupied spaces, conceal ductwork from view, by locating in mechanical shafts, hollow wall construction, or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as specifically shown. Coordinate layout with suspended ceiling and lighting layouts and similar finished work.

Electrical Equipment Spaces: Do not route ductwork through transformer vaults and electrical equipment spaces and enclosures.

Slope shower, locker room, and high moisture ductwork down to air device. Do not provide joints on bottom of duct in longitudinal direction.

Penetrations: Where ducts pass through interior partitions and exterior walls, and are exposed to view, conceal space between construction opening and duct or duct insulation with sheet metal flanges of same gauge as duct. Overlap opening on all four (4) sides by at least 1-1/2 inch. Fasten to duct only.

Coordination: Coordinate duct installations with installation of accessories, dampers, coil frames, equipment, controls and other associated work of ductwork system.

Installation: Install metal ductwork in accordance with SMACNA HVAC Duct Construction Standards.

Temporary Closure: At ends of ducts that are not connected to equipment or air distribution devices at time of ductwork installation, provide temporary closure of polyethylene film or other covering that will prevent entrance of dust and debris until time connections are to be completed.

3.2 INSTALLATION OF DUCT LINER

Install duct liner in accordance with SMACNA HVAC Duct Construction Standards.

Adhere insulation to sheet metal with full coverage of adhesive.

Mechanical fasteners should be of length sufficient to limit compression of liner.

All exposed edges of the liner must be factory or field coated.

Repair liner surface penetrations with adhesive.

3.3 INSTALLATION OF FLEXIBLE DUCTS

Do not exceed 6'-0" for any flexible duct run.

Install in accordance with Chapter 3 of SMACNA "HVAC Duct Construction Standards, Metal and Flexible".

3.4 ADJUSTING AND CLEANING

Clean ductwork internally, unit by unit as it is installed, of dust and debris. Clean external surfaces of foreign substances. Where ductwork is to be painted, clean and prepare surface for painting.

Balancing: Seal any leaks in ductwork that become apparent in balancing process.

END OF SECTION 23 31 13

SECTION 23 33 00

DUCTWORK ACCESSORIES

PART 1 - GENERAL

1.0 DESCRIPTION OF WORK

Types of Ductwork Accessories required for project include the following:

- Manual Volume Dampers
- Control Dampers
- Static Fire Dampers
- Combination Fire/Smoke Dampers
- Turning Vanes
- Duct Hardware
- Duct Access Doors
- Flexible Connections

1.1 QUALITY ASSURANCE

Manufacturer's Qualifications: Firms regularly engaged in manufacture of ductwork accessories, of types and sizes required, whose products have been in satisfactory use in similar service for not less than five (5) years.

Industry Standards: Comply with ASHRAE recommendations pertaining to construction of ductwork accessories, except as otherwise indicated.

UL Compliance: Construct, test, and label fire dampers in accordance with UL Standard 555 "Fire Dampers and Ceiling Dampers" and UL Standard 555S "Motor-Driven Fire/Smoke Dampers".

NFPA Compliance: Comply with applicable provisions of NFPA 90A "Air Conditioning and Ventilating Systems", pertaining to installation of ductwork accessories.

SMACNA Compliance: Comply with "Fire Damper and Heat Stop Guide" for the installation of fire, smoke, and fire/smoke dampers.

All fire dampers, smoke dampers, fire/smoke dampers and radiation dampers shall meet the latest local building code requirements.

1.2 SUBMITTALS

Product Data: Submit manufacturer's technical product data for each type of ductwork accessory, including dimensions, capacities, and materials of construction, and installation instructions.

Shop Drawings: Submit manufacturer's assembly-type shop drawings for each type of ductwork accessory showing interfacing requirements with ductwork, method of fastening or support, and methods of assembly of components. Include details of construction equipment and accessories being provided.

Submittals for all damper types specified in this section shall include a schedule for each damper indicating net free area, actual face velocity and pressure drop (at sea level) based on net free area and the maximum air quantity which will be passing through the damper. Submittals without this information will be rejected.

Record Drawings: At project closeout, submit record drawings of installed systems products, in accordance with requirements of Division 1.

Maintenance Data: Submit manufacturer's maintenance data including parts lists for each type of duct accessory. Include this data, product data, and shop drawings in maintenance manual; in accordance with requirements of Division 1.

PART 2 - PRODUCTS

2.0 MANUFACTURERS

Manufacturer: Subject to compliance with requirements, provide products by one of the following:

Dampers:

- American Warming and Ventilating
- Air Balance, Inc.
- Arrow Louver & Damper; Division of Arrow United Industries, Inc.
- Louvers & Dampers, Inc.
- Penn Ventilator Co.
- SafeAir Dowco
- Cesco-Advanced Air
- Ruskin
- Vent Products Inc.
- Greenheck
- Pottorff
- NCA, Industries, Inc.
- United Enertech

Smoke, Static/Dynamic Fire, and Combination Fire/Smoke Dampers:

- Air Balance, Inc.
- Ruskin
- Greenheck
- Pottorff
- NCA Industries, Inc.
- United Enertech

Turning Vanes:

- Aero Dyne Co.
- Airsan Corp.
- Duro Dyne Corp.
- Hart & Cooley Mfg. Co.
- Hercules

Duct Hardware:

- Ventfabrics, Inc.
- Young Regulator Co.

Duct Access Doors:

- Flexmaster (Inspector Series)
- Cesco-Advanced Air
- Duro Dyne Corp.

Ventfabrics, Inc.

Flexible Connections:

Duro Dyne Corp.
Ventfabrics, Inc.
General Rubber Corp. (Process and Exhaust Only)

2.1 DAMPERS

Low Pressure Rectangular Dampers (Less than 2,000 FPM and Under 4-Inch W.C. S.P. Differential):

For 12-inch in height or larger, use multiple opposed blade type and close fitted to ducts. 16 Gauge galvanized steel frame and blades with carbon steel shaft mounted with stainless steel bearings, stainless steel jamb seals and silicone blade edge seals.
Linkage shall be in-jamb fixed type located outside the airstream made of plated steel tie bar and crank plates, with stainless steel pivots. Maximum damper panel width is 48-inch. Provide jack shafting when duct size required is greater than 48-inch wide. Provide notched shaft end indicating damper position, locking quadrant to fix damper position and handle. For flat oval and round ductwork, provide Type C housing.
For ducts less than 12-inch in height, use 16 gauge frame and 20 gauge blade galvanized steel, steel axle with nylon bearings, locking quadrant handle and notched shaft end indicating damper position.

Low Pressure Round Dampers (Less than 1,500 FPM and Under 1-Inch W.C. S.P. Differential):

For Dampers 4-inch diameter through 18-inch diameter use 18 gauge galvanized steel frame and the following blade construction:

4-Inch thru 12-inch diameter	22 gauge galvanized steel
13-Inch thru 18-inch diameter	20 gauge galvanized steel

Carbon steel axle shaft with retainers mounted on stainless steel bearings with notched end shaft indicating damper position, locking quadrant and handle.

Medium High Pressure Rectangular Dampers (Less than 4,000 FPM and Under 6-Inch W.C. (48-Inch Wide or Less) S.P. or 8-Inch W.C. S.P. (36-Inch Wide or Less)):

Use opposed blade dampers for volume control and parallel blade for isolation/shutoff service.
16 Gauge galvanized steel frame with welded corners. Double skin galvanized steel blades with single-lock seam, airfoil shape. Double durometer vinyl blade edge seals and metallic compression seals at the jambs. Solid carbon steel axles mounted on stainless steel bearings. In-jamb type linkage located outside the air stream. 48-Inch wide and 60-inch high maximum damper size. For fixed position balancing damper, delete blades to maintain 30 percent free area with all other damper blades are 100 percent closed. For isolation or shutoff duty, damper leakage shall not exceed 9.5 CFM/square foot at 4-inch W.C. S.P. differential. Provide extended shaft with notched end indicating damper position, locking quadrant and handle.
Air Balance Model AC-515/AC-516 (Steel)

Medium/High Pressure Round Dampers (Less than 3,000 FPM and Under 4-Inch W.C. S.P. Differential):

Galvanized steel damper frame construction as follows:

	ROUND
Under 6-inch diameter	12 gauge

6-Inch to 18-inch diameter	14 gauge
20-Inch to 30-inch diameter	2 x 1/2 x 1/8 channel
32-Inch to 42-inch diameter	2 x 1 x 1/8 channel

Galvanized steel damper blades as follows:

ROUND	
4-Inch to 12-inch diameter	14 gauge
14-Inch to 18-inch diameter	12 gauge
20-Inch to 42-inch diameter	10 gauge

1/2-Inch diameter galvanized steel axles up to 18-inch diameter and 18-inch wide flat oval, and 3/4-inch diameter plated steel sleeve pressed in to the frame with stainless steel thrust washers with stainless steel bearings.
Provide notched end shaft to indicate damper position, locking quadrant and lever handle.
For fixed position balancing damper, provide reduced blade area to provide 30 percent free area with damper 100 percent closed.

2.2 CONTROL DAMPERS

Provide opposed blade dampers for volume control and parallel blade for isolation/shutoff service. 16 Gauge galvanized steel frame with reinforced corners.

Double skin galvanized steel blades, airfoil shape, 14 gauge minimum thickness.
AWV Model VC-422

Vinyl blade edge seals and stainless steel compression seals at the jambs.

Leakage shall not exceed AMCA Class (8 CFM/square foot at 4-inch W.C. S.P.)

For isolation dampers, provide factory supplied electric motor operators with quantities, voltage and sizes suitable for proper operation at the velocity and pressures the dampers will be operating at.

2.3 STATIC FIRE DAMPERS

General: Static fire damper with curtain style blades meeting the requirements of UL 555.

Rating: UL 555 fire resistance rating of 1-1/2 hours.

Fire Closure Temperature: Heat responsive device (fusible link) rated to close the damper when temperature at the damper reaches 165 degree F.

Construction: Galvanized steel frame in gauges required by manufacturer's UL listing, galvanized curtain style blades mounted outside the air stream, replaceable fusible link, supplied as a single assembly with integral factory sleeve and retaining angles sized to provide installation overlap in accordance with the manufacturer's UL listing.

Duct Transition Connection: The Contractor is responsible for selecting and installing the appropriate duct transition.

2.4 COMBINATION FIRE/SMOKE DAMPERS

General: Fire/Smoke dampers with airfoil blades meeting the requirements of UL Standard 555 6th Edition and 555S 4th Edition.

Rating: UL 555 fire resistance rating of 1-1/2 hours.

Operating Temperature: UL 555S elevated temperature rating of 250 degree F.

Leakage: UL 555S Class II Leakage Rating.

Differential Pressure: Minimum UL 555S differential pressure rating of 4-inch w.g.

Velocity: Minimum UL 555S velocity rating of 3000 fpm.

Frame: Structural galvanized steel hat channel. Top and bottom frame members on dampers less than 7-inch high shall be low profile design to maximize the free area of these smaller dampers. Four-piece construction with 1-1/2 inch minimum integral overlapping gusset reinforcements in each corner to assure square corners and provide maximum resistance to racking.

Blades: 16 Gauge galvanized steel with full-length structural reinforcement and a double skin airfoil shape. Each blade shall be symmetrical relative to its axle pivot point, presenting identical performance characteristics with air flowing in either direction through the damper. Provide symmetrical blades of varying size as required to completely fill the damper opening.

Blade Stops: Blade stops at top and bottom of damper frame shall occupy no more than 1/2-inch of the damper opening area to allow for maximum free area and to minimize pressure loss across the damper.

Linkage: Concealed in jamb.

Seals: Extruded silicone rubber permanently bonded to the appropriate blade edges.

Jamb: Flexible stainless steel compression type.

Axles: Minimum 1/2-inch diameter plated steel.

Bearings: Stainless steel sleeve type rotating in polished extruded holes in the damper frame.

Actuator: Normally closed, 120V, 60 Hz electric motor mounted outside the air stream that meets IBC 15-second operation requirement and is tested for minimum of one (1) year of holding with no evidence of spring return failure.

Actuators shall return to fully open (normal) position when reset.
Provide actuators as manufactured by Belimo, or equal.

Sleeve: Factory supplied as a single assembly with an integral factory sleeve.

Retaining Angles: Factory supplied and sized to provide installation overlap in accordance with the manufacturer's UL listing.

Duct Transition Connection: The Contractor is responsible for selecting and installing the appropriate duct transition.

All factory wiring to be done in accordance with N.E.C. (NFPA 70). Refer to Detail on Drawings; Sequence of Operation on Mechanical Drawing and/or Electrical portion of the Contract Documents for full coordination of equipment and controls. Coordinate actuator mounting arrangement with Drawings (i.e. right or left mounting).

For grilles mounted in rated walls, provide front access dampers.

Heat-Activated Temperature Release Device: Control close and lock damper during test, smoke detection, power failure, or fire conditions through actuator closure spring. At no time shall actuator disengage from damper blades. Allow damper to be automatically reset remotely or manually reset locally after test, smoke detection, or power failure. 165 Degree F release temperature.

2.5 TURNING VANES

Fabricated Turning Vanes: Provide fabricated 22 gauge, single blade 4-1/2 inch radius, 3-1/4 inch spacing turning vanes and Type 2, 4-1/2 inch wide runners, constructed in accordance with SMACNA "HVAC Duct Construction Standards" Fig 2.3.

Manufactured Turning Vanes: Provide single blade turning vanes constructed of 1-1/2 inch wide curved blades set at 3/4-inch O.C., supported with bars perpendicular to blades set at 2-inch O.C., and set into side strips suitable for mounting in ductwork.

Do not use trailing edge turning vanes.

2.6 DUCT HARDWARE

General: Provide duct hardware, manufactured by one manufacturer for all items on project, for the following:

Test Holes: Provide in ductwork at fan inlet and outlet, and elsewhere as indicated, duct test holes, consisting of slot and cover, for instrument tests.
Quadrant Locks: Provide for each manual volume damper, quadrant lock device on one (1) end of shaft; and end bearing plate on other end for damper lengths over 12-inch. Provide extended quadrant locks and end extended bearing plates for externally insulated ductwork.

2.7 DUCT ACCESS DOORS

General: Provide access doors, whether shown or not, at all fire dampers, smoke dampers, temperature control dampers, branch balancing dampers, outside air plenums, inlet of fans, upstream of all duct smoke detectors and all other equipment requiring service and/or access.

Construction: Construct of same or greater gauge as ductwork served, provide insulated doors for insulated ductwork. Provide flush frames for uninsulated ductwork, extended frames for externally insulated duct. All access doors shall have gasket and will be air-tight. Provide one (1) side hinged, other side with one (1) handle-type latch for doors 12-inch high and smaller, two (2) handle-type latches for larger doors. For spiral ductwork, use United McGill combination access section type ARF-SD for non-insulated duct systems and type ARF-ID double wall insulated door for insulated ducted systems (all supply ductwork).

2.8 FLEXIBLE CONNECTIONS

General: Provide flexible duct connections wherever ductwork connects to vibration isolated equipment. Construct flexible connections of neoprene-coated flameproof fabric crimped into duct flanges for attachment to duct and equipment. Make air-tight joint. Provide adequate joint flexibility to allow for thermal, axial, transverse, and torsional movement, and also capable of absorbing vibrations of connected equipment. Shelf life shall be verified to not exceed six (6) months. Any sign of cracking on interior or exterior shall be cause for replacement immediately.

Use the following product types for each application accordingly:

Indoor Equipment Non-Corrosive Air Systems: Heavy glass fabric, double-coated with DuPont's NEOPRENE, non-combustible fabric, fire retardant coating with good resistance to abrasion and flexing. Fabric shall be 30 ounce per square yard, capable of operating at –10 degree F to 200 degree F, waterproof, air tight, 6-inches wide, complies with NFPA 90 and UL Standard #214. "Ventglas" Model as manufactured by VentFabric, Inc.

Outdoor Equipment Non-Corrosive Air Systems (Exposed to Weather and Sun): Heavy glass fabric, double-coated with DuPont's HYPALON, non-combustible fabric, fire retardant coating with superb resistance to sunlight, ozone and weather which has documented 20-year-old exposure tests. Fabric shall be 26 ounce per square yard, capable of operating at –10 degree F to 250 degree F, waterproof, air tight, 6-inches wide, complies with NFPA 90 and UL Standard #214. "Ventlon" Model as manufactured by VentFabrics, Inc.

PART 3 - EXECUTION

3.0 INSPECTION

Examine areas and conditions under which ductwork accessories will be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to the Engineer.

3.1 INSTALLATION OF DUCTWORK ACCESSORIES

Install ductwork accessories in accordance with manufacturer's installation instructions, with applicable portions of details of construction as shown in SMACNA standards, and in accordance with recognized industry practices to ensure that products serve intended function.

Install turning vanes in square or rectangular 90 degree elbows in supply, return and exhaust air systems, and elsewhere as indicated.

Install access doors to open against system air pressure, with latches operable from either side, except outside only where duct is too small for person to enter.

Coordinate with other work, including ductwork, as necessary to interface installation of ductwork accessories properly with other work.

Provide duct access doors whether shown or not for inspection and cleaning before and after all filters, coils, fans, automatic dampers, at fire dampers (minimum 16-inch x 24-inch in ducts larger than 18-inch), fire/smoke dampers, upstream of duct smoke detectors and elsewhere as indicated. Review locations prior to fabrication. Provide multiple access doors for large ductwork to provide adequate reach to equipment.

Install fire dampers and smoke dampers in accordance with manufacturer’s instructions.

Provide fire dampers and smoke dampers at locations shown, where ducts and outlets pass through fire rated components, and where required by Authorities Having Jurisdiction.

Provide balancing dampers at points on low pressure supply, return, and exhaust systems where branches are taken from larger ducts and as required for air balancing.

Provide balancing dampers on high pressure systems where indicated. Use splitter dampers only where indicated on Drawings.

Provide flexible connections immediately adjacent to equipment in ducts associated with fans and equipment subject to forced vibration. Provide matching flanged backing frame with flexible connector where flanged fan connections are provided.

Where fire and smoke dampers are installed in fire and smoke rated construction, provide firestopping between fire and fire smoke damper sleeve and substrate.

3.2 FIELD QUALITY CONTROL

Operate installed ductwork accessories to demonstrate compliance with requirements. Test for air leakage while system is operating. Repair or replace faulty accessories, as required to obtain proper operation and leakproof performance.

Test every fire and fire/smoke damper for proper operation, provide letter to the Architect/ Engineer certifying this work is complete and all dampers are functioning properly.

3.3 ADJUSTING AND CLEANING

Adjusting: Adjust ductwork accessories for proper settings, install fusible links in fire dampers and adjust for proper action.

Label access doors in accordance with Division 23 Section "Mechanical Identification".

Final positioning of manual dampers is specified in Division 23 Section "Testing, Adjusting, and Balancing".

Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

3.4 EXTRA STOCK

Furnish extra fusible links to Owner, one (1) link for every ten (10) installed of each temperature range; obtain receipt.

END OF SECTION 23 33 00

SECTION 23 34 13
AIR HANDLING FANS

PART 1 - GENERAL

1.0 DESCRIPTION OF WORK

Extent of Air Handling Equipment Work required by this section is indicated on drawings and schedules, and by requirements of this section.

This Section includes the following types of Air-Handling Equipment:
Centrifugal Roof Ventilators
In-line Fans

Refer to other Division 23 sections for vibration control; control system; sequence of operation; testing, adjusting and balancing.

Refer to Division 26 section for the following work; not work of this section.

Power supply wiring from power source to power connections at air handling units.

Refer to Division 23 section "Mechanical/Electrical Requirements for Mechanical Equipment".

1.1 QUALITY ASSURANCE

Manufacturer's Qualifications: Firms regularly engaged in manufacture of air handling equipment of types and sizes required, whose products have been in satisfactory use in similar service for not less than three (3) years.

Codes and Standards:

Fans Performance Ratings: Establish flow rate, pressure, power air density, speed of rotation, and efficiency by factory tests and ratings in accordance with AMCA Standard 210/ASHRAE Standard 51 - Laboratory Methods of Testing Fans for Rating.
UL Compliance: Provide air handling equipment which are listed by UL and have UL label affixed.
UL Compliance: Provide air handling equipment which are designed, manufactured, and tested in accordance with UL 805 "Power Ventilators".
NEMA Compliance: Provide motors and electrical accessories complying with NEMA Standards.
Sound Power Level Ratings: Comply with AMCA Standard 301 "Method for Calculating Fan Sound Ratings from Laboratory Test Data". Test fans in accordance with AMCA Standard 300 "Test Code for Sound Rating". Fans shall be licensed to bear the AMCA Certified Sound Ratings Seal.
Nationally Recognized Testing Laboratory and NEMA Compliance (NRTL): Fans and components shall be NRTL listed and labeled. The term "NRTL" shall be defined in OSHA Regulation 1910.7.
Electrical Component Standards: Components and installation shall comply with NFPA 70 "National Electrical Code".

1.2 SUBMITTALS

Product Data: Submit manufacturer's technical data for air handling equipment including specifications, capacity ratings, sound data, dimensions, weights, materials, operating and service/access clearance accessories furnished, and installation instructions.

Shop Drawings: Submit assembly-type shop drawings showing unit dimensions, construction details, methods of assembly of components, and field connection details.

Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to air-handling units. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are manufacturer-installed and portions to be field-installed.

Record Drawings: At project closeout, submit record drawings of installed systems products; in accordance with requirements of Division 1.

Maintenance Data: Submit maintenance data and parts list for each type of power and gravity ventilator, accessory, and control. Include this data, product data, shop drawings, and wiring diagrams in maintenance manuals in accordance with requirements of Division 1.

1.3 DELIVERY, STORAGE, AND HANDLING

Lift and support units with the manufacturer's designated lifting or supporting points.

Disassemble and reassemble units as required for movement into the final location following manufacturer's written instructions.

Deliver fan units as a factory-assembled unit to the extent allowable by shipping limitations, with protective crating and covering.

1.4 SEQUENCING AND SCHEDULING

Coordinate the size and location of concrete equipment pads. Cast anchor bolt inserts into pad.

Coordinate the installation of roof curbs, equipment supports, and roof penetrations.

Coordinate the size and location of structural steel support members.

1.5 EXTRA MATERIALS

Furnish one (1) additional complete set of belts for each belt-driven fan.

PART 2 - PRODUCTS

2.0 MANUFACTURERS

Manufacturers: Subject to compliance with requirements, provide products by one of the following:

Inline Centrifugal Fans:

Acme Engineering & Manufacturing Corp.
Loren Cook Co.
Penn Barry.
Solar & Palau.
Greenheck
New York Blower Co
Twin City Fan and Blower Co (TCF)

Centrifugal Roof Ventilators:

Acme Engineering & Manufacturing Corp.
Aerovent, Inc.
Carnes Company, Inc.
Loren Cook Co.
Jenn Co Fan.
Penn Barry.
Greenheck
Twin City Fan & Blower Co. (TCF)

2.1 FANS, GENERAL

General: Provide fans that are factory fabricated and assembled, factory tested, and factory finished, with indicated capacities and characteristics.

Fans and Shafts: Statically and dynamically balanced and designed for continuous operation at the maximum rated fan speed and motor horsepower.

Fan Shaft: Turned, ground, and polished steel designed to operate at no more than 70 percent of the first critical speed at the top of the speed range of the fan's class.

Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.

Service Factor: 1.4.

Belts: Oil-resistant, non-sparking, and non-static.

Motors and Fan Wheel Pulleys: Adjustable pitch for use with motors through 15 HP; fixed pitch for use with motors larger than 15 HP. Select pulley so that pitch adjustment is at the middle of the adjustment range at fan design conditions. Provide premium energy efficient motor.

Belt Guards: Provide steel belt guards for motors mounted on the outside of the fan cabinet.

Shaft Bearings: Provide type indicated, having a median life "Rating Life" AFBMA L10 of 100,000 hrs calculated in accordance with AFBMA Standard 9 for ball bearings and AFBMA Standard 11 for roller bearings.

Factory Finish: The following finishes are required:

Sheet Metal Parts: Prime coating prior to final assembly.
Exterior Surfaces: Baked-enamel finish coat after assembly.

Vibration: Provide vibration isolators as scheduled and specified in other Division 23 sections.

2.2 INLINE CENTRIFUGAL FANS

General Description: Inline, belt-driven, centrifugal fans consisting of housing, wheel, outlet guide vanes, fan shaft, bearings, drive assembly, motor and disconnect switch, mounting brackets, and accessories.

Housing: Split, spun-aluminum housing, with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.

Direct-Drive Units: Motor encased in housing out of air stream, factory-wired to disconnect located on outside of fan housing.

Belt-Drive Units: Motor mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.

Wheel: Aluminum, airfoil blades welded to aluminum hub.

Bearings: Grease lubricated ball or roller anti-friction type with extended lubrication lines to outside fan housing.

Accessories: The following accessories are required as indicated:

Volume Control Damper: Manual operated with quadrant lock, located in fan outlet.
Companion Flanges: For inlet and outlet duct connections.
Fan Guards: Expanded metal in removable frame.
Speed Control: Variable speed switch with On-Off control and speed control for 100 to 50 percent of fan air delivery.

2.3 CENTRIFUGAL ROOF VENTILATORS

General Description: Belt-driven or direct-drive as indicated, centrifugal consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.

Housing: Heavy-gauge, removable, spun-aluminum, dome top and outlet baffle; square, one-piece, hinged, aluminum base with venturi inlet cone.

Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains.

Fan Wheel: Aluminum hub and wheel with backward-inclined blades.

Belt-Driven Drive Assembly: Resiliently mounted to the housing, with the following features:

Pulleys: Cast iron, adjustable-pitch.
Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
Fan Shaft: Turned, ground, and polished steel drive shaft keyed to wheel hub.
Fan and motor isolated from exhaust air stream.

Accessories: The following items are required as indicated:

Disconnect Switch: Non-fusible type, with thermal overload protection mounted inside fan housing, factory-wired through an internal aluminum conduit.
Bird Screens: Removable 1/2-inch mesh, 16 gauge, aluminum or brass wire.
Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base, factory set to close when fan stops.
Roof Curbs: Prefabricated, heavy-gauge, galvanized steel; mitered and welded corners; 2-inch thick, rigid, fiberglass insulation adhered to inside walls; built-in cant and mounting flange for flat roof decks; and 2-inch wood nailer. Size as required to suit roof opening and fan base.

Overall Height: 12-Inches above roofing.

PART 3 - EXECUTION

3.0 EXAMINATION

Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances, housekeeping pads, and other conditions affecting performance of fans.

Do not proceed until unsatisfactory conditions have been corrected.

3.1 INSTALLATION, GENERAL

Install fans level and plumb, in accordance with manufacturer's written instructions. Support units using vibration control devices as indicated. Vibration control devices are specified in Division 23 Section "Vibration Controls".

Installation of roof curbs is specified in Division 7.
Suspended Units: Suspend units from structural steel support frame using threaded steel rods and vibration isolation springs.

Arrange installation of units to provide access space around air-handling units for service and maintenance.

3.2 CONNECTIONS

Duct installations and connections are specified in other Division 23 sections. Make final duct connections on inlet and outlet duct connections with flexible connections.

Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.

Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 sections. Ensure that rotation is in direction indicated and intended for proper performance. Do not proceed with centrifugal fan start-up until wiring installation is acceptable to Centrifugal Fan Installer.
Temperature control wiring and interlock wiring are specified in Division 23.
Grounding: Connect unit components to ground in accordance with the National Electrical Code.

3.3 FIELD QUALITY CONTROL

Upon completion of installation of air handling equipment, and after motor has been energized with normal power source, test equipment to demonstrate compliance with requirements. Where possible, field correct malfunctioning equipment, then retest to demonstrate compliance. Replace equipment which cannot be satisfactorily corrected.

Manufacturer's Field Inspection: Arrange and pay for a factory-authorized service representative to perform the following:

Inspect the field assembly of components and installation of fans including ductwork and electrical connections.
Prepare a written report on findings and recommended corrective actions.

3.4 ADJUSTING, CLEANING, AND PROTECTING

Start-up, test and adjust air handling equipment in presence of manufacturer's authorized representative.

Adjust damper linkages for proper damper operation.

Clean unit cabinet interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheel and cabinet.

3.5 SPARE PARTS

General: Furnish to Owner with receipt one (1) spare set of belts for each belt driven air handling equipment.

3.6 PRE-STARTUP CHECK

Final Checks Before Start-Up: Perform the following operations and checks before start-up:

Remove shipping blocking and bracing.
Verify unit is secure on mountings and supporting devices and that connections for piping, ductwork, and electrical are complete. Verify proper thermal overload protection is installed in motors, starters, and disconnects.
Perform cleaning and adjusting specified in this Section.
Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearings operations. Reconnect fan drive system, align belts, and install belt guards.
Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
Verify manual and automatic volume control and that fire and smoke dampers in connected ductwork systems are in the full-open position.
Disable automatic temperature control operators.

Starting Procedures for Fans:

Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated RPM.
Replace fan and motor pulleys as required to achieve design conditions.
Measure and record motor electrical values for voltage and amperage.

Shut unit down and reconnect automatic temperature control operators.

Refer to Division 23 Section "Testing, Adjusting, and Balancing" for procedures for air-handling-system testing, adjusting, and balancing.

3.7 DEMONSTRATION

Demonstration Services: Arrange and pay for a factory-authorized service representative to train Owner's maintenance personnel on the following:

Procedures and schedules related to start-up and shutdown, troubleshooting, servicing, preventative maintenance, and how to obtain replacement parts.
Familiarization with contents of Operating and Maintenance Manuals specified in Division 1 Section "Project Closeout" and Division 23 Section "Basic Mechanical Requirements".

Schedule training with at least seven (7) days' advance notice.

END OF SECTION 23 34 13

SECTION 23 36 00
AIR TERMINALS

PART 1 - GENERAL

1.0 DESCRIPTION OF WORK

Extent of Air Terminals Work required by this section is indicated on drawings and schedules, and by requirements of this section.

Types of Air Terminals specified in this section include the following:

Variable Volume Air Terminals

Shutoff, Single Duct, with hot water coil

Refer to other Division 23 sections for external insulation of air terminals; testing, adjusting and balancing of air terminals; temperature controls which are to be furnished by others but installed as work of this section.

Refer to Division 26 sections for the following work; not work of this section.

Power supply wiring from power source to power connection on air terminals. Include starters, disconnects, and required electrical devices, except where specified as furnished, or factory-installed, by manufacturer.

Provide the following electrical work as work of this section, complying with requirements of Division 26 sections:

Control wiring between field-installed controls and air terminals.

Control wiring specified as work of Division 23 for Automatic Temperature Controls is work of that section.

1.1 QUALITY ASSURANCE

Manufacturer's Qualifications: Firms regularly engaged in manufacturer of air terminals with characteristics, sizes, and capacities required, whose products have been in satisfactory use in similar service for not less than five (5) years.

Codes and Standards:

ADC Compliance: Provide air terminals which have been tested and rated in accordance with ADC standards, and bear ADC Seal.
ARI Compliance: Provide air terminals which have been tested and rated in accordance with ARI 880 "Industry Standard for Air Terminals" and bear ARI certification seal.
NFPA Compliance: Construct air terminals using acoustical and thermal insulations complying with NFPA 90A "Air Conditioning and Ventilating Systems".

1.2 SUBMITTALS

Product Data: Submit manufacturer's technical product data, including performance and sound data for each size and type of air terminal furnished; schedule showing drawing designation, room location, number furnished, model number, size, and accessories furnished; and installation and start-up instructions.

Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loadings, required clearances, and methods of assembly of components.

Wiring Diagrams: Submit ladder-type wiring diagrams for electric power and control components, clearly indicating required field electrical connections.

Record Drawings: At project closeout, submit record drawings of installed systems products, in accordance with requirements of Division 23.

Maintenance Data: Submit maintenance data and parts list for each type of air terminal; including "trouble-shooting" maintenance guide. Include this data, product data, shop drawings, and maintenance data in maintenance manual; in accordance with requirements of Division 23.

1.3 DELIVERY, STORAGE, AND HANDLING

Deliver air terminals wrapped in factory-fabricated fiber-board type containers. Identify on outside of container type of air terminal and location to be installed. Avoid crushing or bending and prevent dirt and debris from entering and settling in boxes.

Store air terminals in original cartons and protect from weather and construction work traffic. Where possible, store indoors; when necessary to store outdoors, store above grade and enclose with waterproof wrapping.

PART 2 - PRODUCTS

2.0 MANUFACTURERS

Manufacturer: Subject to compliance with requirements, provide products by one of the following:

Supply Air Terminals:

Trane (The) Co.
Carnes Co.
Titus Products Division
Metal-Aire
Price
Nailor Industries, Inc.
Anemostat
York/Johnson Controls
Krueger

2.1 SUPPLY AIR TERMINALS

General: Provide factory-fabricated and tested air terminals as indicated, selected with performance characteristics which match or exceed those indicated on schedule.

Air terminal units shall be low pressure drop, single duct throttling type pressure independent and suitable for use in variable volume air distribution systems.

Casing shall be 22 gauge galvanized steel construction with internal acoustical coated 1-inch thick, 1-1/2 lb. density fiberglass insulation, inlet and outlet duct connection and discharge sound attenuator, where scheduled.

Internal damper blade shall be extruded aluminum or 18 gauge steel with keyed fit shaft and nylon bushing. Damper shall seal against gasketed stops maximum 2 percent leakage at 3.0-inch S.P. All mechanical parts shall be galvanized or non-ferrous.

Hot water heating coils shall be designed for 200 psig maximum working pressure and 200 degree F maximum operating temperature. Coil shall be serpentine-type, 2-row minimum, constructed of 1/2-inch O.D. copper tubes mechanically bonded to aluminum fins; galvanized steel casing.

Provide factory-installed framed duct access door complete with quarter-turn quick release fasteners in terminal box casing upstream of reheat coil. Access door shall be sized large enough to allow the coil to be inspected and cleaned.

Provide label on each air terminal unit, indicating plan designation, unit size, CFM range and settings and calibration curve.

Controls shall include wall mounted thermostat, modulating damper, damper operator furnished by the Temperature Control Contractor, and factory installed by the equipment manufacturer, pressure independent pneumatic cross-shaped flow sensor with amplifying total pressure pickup points connected in parallel to a central averaging chamber (an inlet velocity sensor with pickup points connected in series shall not be accepted), for measuring inlet volume. The sensor shall amplify duct velocity pressure by a factor of 1.75 and shall maintain control accuracy with the same size inlet duct in any configuration. Specific control component requirements are specified in Division 23 Section Direct Digital Control Systems.

PART 3 - EXECUTION

3.0 INSPECTION

Examine areas and conditions under which air terminals are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.1 INSTALLATION OF AIR TERMINALS

General: Install air terminals as indicated, and in accordance with manufacturer's installation instructions.

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.

Duct Connections: Connect ductwork to air terminals in accordance with Division 23 ductwork sections.

3.2 FIELD QUALITY CONTROL

Upon completion of installation and prior to initial operation, test and demonstrate that air terminals, and duct connections to air terminals, are leak-tight.

Repair or replace air terminals and duct connections as required to eliminate leaks, and retest to demonstrate compliance.

3.3 CLEANING

Clean exposed factory-finished surfaces. Repair any marred or scratched surfaces with manufacturers touch-up paint.

END OF SECTION 23 36 00

SECTION 23 36 50
SOUND ATTENUATORS

PART 1 - GENERAL

1.0 DESCRIPTION OF WORK

Sound Attenuators required by this section are indicated on drawings and schedules, and are not necessarily limited to this section.

Refer to other Division 23 sections for ductwork; external insulation of sound attenuators; not work of this section.

1.1 QUALITY ASSURANCE

Manufacturer's Qualifications: Firms regularly engaged in manufacturer of sound attenuators with characteristics, sizes, and capacities required, whose products have been in satisfactory use in similar service for not less than five (5) years.

Codes and Standards:

NFPA Compliance: Construct sound attenuators using acoustical fill complying with NFPA 90A, "Air Conditioning and Ventilating Systems".
ASTM Compliances: Comply with applicable requirements the current versions of ASTM E90 and E477.

1.2 SUBMITTALS

Product Data: Submit manufacturer's technical product data, including performance data for each size and type of sound attenuator furnished; schedule showing drawing designation, room location, number furnished, model number, size, and accessories furnished; and installation and start-up instructions.

Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loadings, required clearances, and methods of assembly of components.

Record Drawings: At project closeout, submit record drawings of installed systems products, in accordance with requirements of Division 1.

Maintenance Data: Submit maintenance data and parts list for each type of sound attenuator; including "trouble-shooting" maintenance guide. Include this data, product data, and shop drawings in maintenance manual; in accordance with requirements of Division 1.

1.3 DELIVERY, STORAGE, AND HANDLING

Deliver sound attenuators with identification on outside of casings indicating type of sound attenuator and location to be installed. Avoid crushing or bending, and prevent dirt and debris from entering and settling in sound attenuators.

Store sound attenuators so as to protect from weather and construction work traffic. Where possible, store indoors; when necessary to store outdoors, store above grade and enclose with waterproof wrapping.

PART 2 - PRODUCTS

2.0 MANUFACTURERS

Manufacturers: Subject to compliance with requirements, provide products by one of the following:

Aeroacoustic Corporation
Gale Noise Control; Division of Norwood Manufacturing Corp.
Titus Products; Division of Philips Industries Inc.
International Acoustics Company
SEMCO
United Sheet Metal
Rink
Vibro Acoustics
Price Industries

2.1 DUCT SILENCERS

General: Provide factory-fabricated and tested duct silencers as indicated, select with performance characteristics which match, or exceed those indicated on schedule.

Casings: Construct of galvanized sheet metal with gauge and seam construction equal or greater than that recommended by SMACNA Duct Construction Standards for ductwork of same size and pressure class; but not less than 22 gauge for outer casing and 22 gauge for inner casing. All seams shall be lock formed and mastic filled.

Acoustic Fill: Provide inorganic mineral or glass fiber filler material, inert, vermin and moisture proof, of sufficient density to obtain specified acoustic performance. Pack under not less than 5 percent compression to eliminate voids due to vibration and settling.

Acoustic Performance: Provide silencer ratings that have been determined in duct at reverberative room test facility. Test silencer with air flow in both directions through silencer, in accordance with ASTM E477, "Methods of Testing Duct Liner Materials and Prefabricated Silencers for Acoustical and Airflow Performance".

For acoustic ratings, include dynamic insertion loss and self-generated noise power levels for both forward flow (air and noise in same direction) and reverse flow (air and noise in opposite directions) with airflow at the design FPM face velocity.

Aerodynamic Performance: Provide silencers with static pressure loss equal to or less than that scheduled.

Certification: Provide certified test data on dynamic insertion loss, self-noise power levels, and aerodynamic performance. Conduct all rating tests at same facility. Open testing facility for inspection by Architect/Engineer if requested.

PART 3 - EXECUTION

3.0 EXAMINATION

Examine areas and conditions under which sound attenuators are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.1 INSTALLATION OF SOUND ATTENUATORS

General: Install sound attenuators as indicated, and in accordance with manufacturer's installation instructions.

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.

Duct Connections: Connect ductwork to sound attenuators in accordance with Division 23 ductwork sections.

3.2 FIELD QUALITY CONTROL

Upon completion of installation and prior to initial operation, test and demonstrate that sound attenuators, and duct connections to sound attenuators, are leak tight.

Repair or replace sound attenuators and duct connections as required to eliminate leaks, and retest to demonstrate compliance.

3.3 CLEANING

Clean exposed factory finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION 23 36 50

SECTION 23 37 13
AIR OUTLETS & INLETS

PART 1 - GENERAL

1.0 DESCRIPTION OF WORK

Extent of Air Outlets and Inlets Work is indicated by drawings and schedules, and by requirements of this section.

Types of Air Outlets and Inlets required for project include the following:

- Diffusers
- Registers and Grilles

Refer to other Division 23 sections for ductwork, duct accessories; testing and balancing; not work of this section.

1.1 QUALITY ASSURANCE

Manufacturer's Qualifications: Firms regularly engaged in manufacture of air outlets and inlets of types and capacities required, whose products have been in satisfactory use in similar service for not less than five (5) years.

Codes and Standards:

ARI Compliance: Test and rate air outlets and inlets in accordance with ARI 650 "Standard for Air Outlets and Inlets".
ASHRAE Compliance: Test and rate air outlets and inlets in accordance with ASHRAE 70 "Method of Testing for Rating the Air Flow Performance of Outlets and Inlets".
ADC Compliance: Test and rate air outlets and inlets in certified laboratories under requirements of ADC 1062 "Certification, Rating and Test Manual".
ADC Seal: Provide air outlets and inlets bearing ADC Certified Rating Seal.
NFPA Compliance: Install air outlets and inlets in accordance with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems".

1.2 SUBMITTALS

Product Data: Submit manufacturer's technical product data for air outlets and inlets including the following:

Schedule of air outlets and inlets indicating drawing designation, room location, number furnished, model number, size, and accessories furnished.
Data sheet for each type of air outlet and inlet, and accessory furnished; indicating construction, finish, and mounting details.
Performance data for each type of air outlet and inlet furnished, including aspiration ability, temperature and velocity traverses, throw and drop, and noise criteria ratings. Indicate selections on data.

Shop Drawings: Submit manufacturer's assembly-type shop drawing for each type of air outlet and inlet, indicating materials and methods of assembly of components.

Record Drawings: At project closeout, submit record drawings of installed systems products, in accordance with requirements of Division 1.

Maintenance Data: Submit maintenance data, including cleaning instructions for finishes, and spare parts lists. Include this data, product data, and shop drawings in maintenance manuals; in accordance with requirements of Division 1.

1.3 DELIVERY, STORAGE AND HANDLING

Deliver air outlets and inlets wrapped in factory-fabricated fiber-board type containers. Identify on outside of container type of outlet or inlet and location to be installed. Avoid crushing or bending and prevent dirt and debris from entering and settling in devices.

Store air outlets and inlets in original cartons and protect from weather and construction work traffic. Where possible, store indoors; when necessary to store outdoors, store above grade and enclose with waterproof wrapping.

PART 2 - PRODUCTS

2.0 MANUFACTURERS

Manufacturer: Subject to compliance with requirements, provide products by one of the following:

Diffusers, Registers and Grilles:

Anemostat Products Division; Dynamics Corp. of America
Carnes Co.; Division of Wehr Corp.
Krueger; Division of Philips Industries, Inc.
Titus Products Division; Philips Industries, Inc.
Metal-Aire
Nailor Industries, Inc.
E.H. Price.

2.1 AIR DIFFUSERS

General: Except as otherwise indicated, provide manufacturer's standard air diffusers where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.

Performance: Provide air diffusers that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device as listed in manufacturer's current data.

Surface (Wall or Ceiling) compatibility: Provide diffusers with border styles that are compatible with adjacent systems, and that are specifically manufactured to fit into surface with accurate fit and adequate support. Refer to general construction drawings and specifications for types of systems which will contain each type of air diffuser.

Types: Provide diffusers of type, capacity, and with accessories and finishes as listed on Air Device Schedule.

2.2 REGISTERS AND GRILLES

General: Except as otherwise indicated, provide manufacturer's standard registers and grilles where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.

Performance: Provide registers and grilles that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device as listed in manufacturer's current data.

Wall Compatibility: Provide registers and grilles with border styles that are compatible with adjacent wall systems, and that are specifically manufactured to fit into wall construction with accurate fit and adequate support. Refer to general construction drawings and specifications for types of wall construction which will contain each type of wall register and grille.

Types: Provide registers and grilles of type, capacity, and with accessories and finishes as listed on air device schedule.

PART 3 - EXECUTION

3.0 INSPECTION

Examine areas and conditions under which air outlets and inlets are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.1 INSTALLATION

General: Install air outlets and inlets in accordance with manufacturer's written instructions and in accordance with recognized industry practices to insure that products serve intended functions.

Coordinate with other work, including ductwork and duct accessories, as necessary to interface installation of air outlets and inlets with other work.

Locate ceiling air diffusers, registers, and grilles, as indicated on general construction "Reflected Ceiling Plans". Unless otherwise indicated, locate units in center of acoustical ceiling modules.

END OF SECTION 23 37 13

SECTION 23 52 16
CONDENSING BOILERS

PART 1 - GENERAL

1.0 DESCRIPTION OF WORK

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

Extent of Condensing Boiler Work required by this section is indicated on drawings and schedules, and by the requirements of this section.

Types of Condensing Boilers specified in this section include factory fabricated and assembled Gas-fired Boilers, Trim, and accessories for generating hot water.

Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3 for Concrete Pads; not work of this section.

Refer to other Division 23 Sections for piping, specialties, water treatment, pumps, breechings, temperature controls, etc., required external to boilers for installation; not work of this section.

Electrical Work: Refer to Division 23 Section “Mech/Elec Requirements for Mechanical Equipment” for requirements.

Electrical Work: Provide the following wiring as work of this section, in accordance with requirements of Division 26;

Furnish to Electrical Installer, burner emergency shutoff switch.
Provide wiring between boiler control panel and thermostats, aquastats, pressurestats, and any other control device.
Provide factory-mounted and wired controls and electrical devices as specified in this section.

Refer to Division 26 section for other electrical work including motor starters, disconnects, wires/cables, raceways, and other required electrical devices; not work of this section

1.1 QUALITY ASSURANCE

Manufacturer’s Qualifications: Firms regularly engaged in manufacture of condensing boilers, of types and capacities required, whose products have been in satisfactory use in similar service for not less than five (5) years.

Manufacturer’s Test: All boilers shall be factory assembled and tested. Submit test results to Architect/Engineer prior to shipping.

Codes and Standards:

Condensing Boilers

NFPA Compliance: Install gas-fired condensing boilers in accordance with NFPA Code 54 “National Fuel Gas Code”.
ASME Compliance: Construct condensing boilers in accordance with ASME Boiler and Pressure Vessel Code, Section IV “Heating Boilers”. Controls shall be per ASME, CSD-1.

ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to “Gas and Oil Fired Boilers – Minimum Efficiency Requirements”.
UL and NEMA Compliance: Provide condensing boiler ancillary electrical components which have been “Listed” and “Labeled” by UL, and comply with NEMA standards. “Listed” and “Labeled” shall be defined by NEC, Article 100.
UL Compliance: Test boilers for compliance with UL 705, “Commercial-Industrial Gas Heating Equipment”. Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.
FM Compliance: Provide control devices and control sequences in accordance with requirements of Factory Mutual (FM).

1.2 SUBMITTALS

Product Data: Submit manufacturer’s technical product data, including rated capacities of selected model clearly indicated, weights (shipping and operating), furnished specialties, flue sizing and materials recommendations and accessories; and installation and start-up instructions.

Shop Drawings: Submit manufacturer’s assembly-type shop drawings indicating dimensions, weights, loadings, required clearances, and method of field assembly, components and location and size of each field connection.

Wiring Diagrams: Submit manufacturer’s electrical requirements for power supply wiring to condensing boilers. Submit manufacturer’s ladder-type wiring diagrams and control wiring required for final installation of condensing boilers and controls. Clearly differentiate between portions of wiring that are factory installed and portions to be field-installed.

Record Drawings: At project closeout, submit record drawings of installed products in accordance with requirements of Division 1.

Maintenance Data: Submit maintenance data and parts list for each condensing boiler, control, and accessory; including “trouble-shooting” maintenance guide. Include this data, product data, shop drawings, and wiring diagrams in maintenance manual; in accordance with requirements of Division 1.

1.3 DELIVERY, STORAGE AND HANDLING

Handle boiler sections and equipment carefully to prevent damage, breaking and scoring. Do not install damaged sections or components; replace with new.

Store boiler sections and equipment in clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.

Comply with manufacturer’s rigging and moving instructions for unloading boilers, and moving them to final location.

1.4 WARRANTY

Special Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period.

Manufacturers standard heat exchanger warranty, ten years from date of manufacture.

PART 2 - PRODUCTS

2.0 MANUFACTURERS

Manufacturer's: Subject to compliance with requirements, provide products by one of the following.

Condensing Boilers

Reillo
AERCO International
Lochinvar Corporation

2.1 WATER-TUBE BOILERS

Description: Factory-fabricated, -assembled, and -tested, water-tube condensing boiler with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls.

Heat Exchanger: stainless-steel.

Combustion Chamber: Stainless steel, sealed.

Burner: Natural gas, forced draft drawing from gas premixing valve.

Blower: Centrifugal fan to operate during each burner firing sequence and to prepurge and postpurge the combustion chamber.

Motors: Comply with requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

Gas Train: Combination gas valve with manual shutoff and pressure regulator.

Ignition: Silicone carbide hot-surface ignition that includes flame safety supervision and 100 percent main-valve shutoff.

Integral Circulator: Cast-iron body and stainless-steel impeller sized for minimum flow required in heat exchanger.

Casing:

Jacket: Sheet metal, with snap-in or interlocking closures, fully insulated.
Control Compartment Enclosures: NEMA 250, Type 1A.
Finish: Textured epoxy.
Combustion-Air Connections: Inlet and vent duct collars.
Mounting base to secure boiler.

2.2 HOT WATER SERVICE

Include devices sized to comply with ANSI B31.9, "Building Services Piping."

Safety Relief Valve: ASME rated.

Pressure and Temperature Gage: Minimum 3-1/2-inch-diameter, combination water-pressure and -temperature gage. Gages shall have operating-pressure and -temperature ranges so normal operating range is about 50 percent of full range.

Boiler Air Vent.

Drain Valve: Minimum NPS 3/4 hose-end gate valve.

Circulation Pump: Non-overloading, in-line pump with split-capacitor motor having thermal-overload protection and lubricated bearings; designed to operate at specified boiler pressures and temperatures.

2.3 CONTROLS

Refer to Division 23 Sections.

Boiler operating controls shall include the following devices and features:

Control transformer.
Set-Point Adjust: Set points shall be adjustable.
Operating Pressure Control: Factory wired and mounted to cycle burner.
Low-Water Cutoff and Pump Control: Cycle feedwater pump(s) for makeup water control.
Sequence of Operation: Electric, factory-fabricated and field-installed panel to control burner firing rate to maintain space temperature in response to thermostat with heat anticipator located in heated space.
Sequence of Operation: Electric, factory-fabricated and field-installed panel to control burner firing rate to reset supply-water temperature inversely with outside-air temperature.

Include automatic, alternating-firing sequence for multiple boilers to ensure maximum system efficiency throughout the load range and to provide equal runtime for boilers.

Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.

High Cutoff: Automatic reset stops burner if operating conditions rise above maximum boiler design temperature or pressure.
Low-Water Cutoff Switch: Electronic probe shall prevent burner operation on low water. Cutoff switch shall be automatic-reset type.
Blocked Inlet Safety Switch: Manual-reset pressure switch field mounted on boiler combustion-air inlet.
Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.

Building Automation System Interface: Factory install hardware and software to enable building automation system to monitor, control, and display boiler status and alarms.

Hardwired Points:

Monitoring: On/off status, common trouble alarm, low water level alarm.

The boiler shall have a touchscreen display located outside the front panel and a service screen located inside the front panel.
The outer display shall have a 7” color touchscreen and shall provide full diagnostics including real time data logging.
The control shall be capable of lead/lag sequencing up to eight 8 boilers in “Cascade”.

The control must display any error codes whether automatically reset or manually reset.
The boiler shall be provided with Bacnet communication capabilities.
The boiler control system shall be capable of accepting 0-10VDC remote external analog signal to control the temperature set point.
The control system shall be capable of resetting the set point based on outdoor air temperature.
The control shall monitor flue gas temperature and stop the boiler if the temperature is excessive.
The boiler safety control shall be furnished with controls for low gas pressure and high gas pressure, blower air proving, blocked flue, blocked condensate, water pressure, high limit, stack limit and flow switch.
The control shall graphically show the firing rate of each module in the boiler and each boiler in the cascade.
The boiler control software shall have the capability to be upgraded via USB stick.
A communication interface with building automation system shall enable building automation system operator to remotely control and monitor the boiler from an operator workstation. Control features available, and monitoring points displayed, locally at boiler control panel shall be available through building automation system.

2.4 ELECTRICAL POWER

Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.

Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.

Provide each motor with overcurrent protection.

2.5 VENTING KITS

Kit: Complete system, ASTM AL 959, Type AL 29-4C stainless steel, pipe, vent terminal, thimble, indoor plate, vent adapter, condensate trap and dilution tank, and sealant.

Combustion-Air Intake: Complete system, galvanized steel vent terminal with screen, inlet air coupling, and sealant. Follow manufacturer's recommendations.

2.6 CONDENSATE NEUTRALIZATION SYSTEM

Provide Condensate Neutralization System for flue condensation (as recommended by mfg), prior to routing condensate to the sanitary sewer system.

PART 3 - EXECUTION

3.0 INSPECTION

Examine areas and conditions under which condensing boilers are to be installed, and substrate which will support boilers. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.1 INSTALLATION OF CONDENSING BOILERS

General: Install boilers in accordance with manufacturer's installation instructions, in accordance with State and local code requirements, and in accordance with requirements of local Utility Company. Install units plumb and level, to tolerance of 1/8-inch in 10'-0" in both directions. Maintain manufacturer's clearances around and over boilers.

Support: Install boilers on 4-inch thick concrete pad, 6-inch larger on each side that base of unit. Boilers shall be installed with factory supplied legs or "feet" so that boiler casing is not in contact with the floor.

Erection: Assemble boiler trim shipped loose, or unassembled for shipping purposes. Follow manufacturer's installation instructions.

Electrical Work: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram to electrical installer.

Verify that electrical work installation is in accordance with manufacturer's submittal and installation requirements of Division 26 Sections. Do not proceed with equipment start-up until electrical work is acceptable to equipment installer.

Gas Piping: Refer to Division 23 section "Natural Gas Systems". Connect gas piping to boiler, full size of boiler gas train inlet, provide union with sufficient clearance for burner removal and service.

Hot Water Piping: Refer to Division 23 section "Hydronic Piping". Connect supply and return boiler tappings as indicated, with shutoff valve and union or flange at each connection.

Install piping adjacent to boiler to allow service and maintenance.

Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.

Connect piping to boilers, except safety relief valve connections, with flexible connectors of materials suitable for service. Flexible connectors and their installation are specified in Division 23 Section "Common Work Results for HVAC,"

Install piping from safety relief valves to nearest floor drain.

Boiler Venting:

Install flue venting kit and combustion-air intake.
Connect full size to boiler connections.

Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.2 FIELD QUALITY CONTROL

Flush and clean boilers upon completion of installation, in accordance with manufacture's start-up instructions.

Hydrostatically test assembled boiler and piping in accordance with applicable sections of ASME Boiler and Pressure Vessel Code.

Arrange with National Board of Boiler and Pressure Vessel Inspectors for inspection of boiler piping, observation of hydrostatic testing, and for certification of completed boiler units.

Start-up boilers, in accordance with manufacturer's start-up instructions, and in presence of boiler manufacturer's representative. Test controls and demonstrate compliance with requirements. Adjust burner for maximum burning efficiency. Replace damaged or malfunctioning controls and equipment.

3.3 CLOSEOUT PROCEDURES

Owner's Instructions: Provide services of manufacturer's technical representative for one (1) 8-hour day to instruct Owner's personnel in operation and maintenance of boilers.

3.4 ADJUSTING AND CLEANING

Clean and flush hydronic piping systems. Remove, clean, and replace strainer screens. After cleaning and flushing hydronic piping system, but before balancing, remove disposable fine mesh strainers in pump suction diffusers.

Mark calibrated nameplates of pump discharge valves after hydronic system balancing has been completed, to permanently indicate final balanced position.

Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

3.5 DEMONSTRATION

Services: After testing and inspection is complete, provide the services of an authorized factory service representative to perform start-up and operation demonstration service.

Start-up: Perform services in accordance with manufacturer's written start-up instructions. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

Maintenance and Operation Training: As a part of the maintenance and operating instructions, review data in operating and maintenance manual, including preventative maintenance schedule and procedures, and procedures for obtaining repair parts and technical assistance. Demonstrate all phases of operation including start-up and shutdown.

Schedule training with Owner, provide at least seven (7) day notice to Architect/ Engineer.

Provide Combustion Test Record for each Boiler, which shall include a minimum of the following information submitted following the test.

TIME:
DATE:

FUEL SOURCE:
- Natural Gas: _____ BTU/cu.ft.
- Propane: _____ BTU/cu.ft.

- Mid Range Manifold Pressure: _____ Water Column Inches (w.c.in.)

TEST RESULTS:
- Combustion Efficiency: _____ %
- Ambient Temperature: _____ °F
- Stack Temperature: _____ °F
- Oxygen: _____ %
- Carbon Monoxide: _____ PPM
- Carbon Dioxide: _____ %
- Combustible Gases: _____ %
- Stack Draft (Inches H_2O): _____
- Excess Air: _____ %
- Oxides of Nitrogen: _____ PPM
- Sulfur Dioxide: _____ PPM
- Carbon Monoxide Alarm: _____ PPM

TEST PERFORMED BY:

END OF SECTION 23 52 16

SECTION 23 57 00
HEAT EXCHANGERS

PART 1 - GENERAL

1.0 DESCRIPTION OF WORK

Extent of Heat Exchangers Work required by this section is indicated on drawings and schedules, and by requirements of this section.

Types of Heat Exchangers specified in this section include the following:

Water-to-Water Plate and Frame Heat Exchanger.

Refer to other Division 23 sections for insulation of heat exchangers; piping, valves, specialties, and controls required in conjunction with heat exchangers; not work of this section.

1.1 QUALITY ASSURANCE

Manufacturer's Qualifications: Firms regularly engaged in manufacture of heat exchangers, of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than five (5) years.

Codes and Standards:

ASME Compliance: Construct heat exchangers in accordance with ASME Boiler and Pressure Vessel Code, Section VIII "Pressure Vessels", Division 1.
TEMA Compliance: Construct and install heat exchangers in accordance with "Standards of the Tubular Exchanger Manufacturers Association".
AHRI-400 Certification: Construct plate and frame or bronzed plate heat exchangers in accordance with AHRI-400.

1.2 SUBMITTALS

Product Data: Submit manufacturer's technical product data for heat exchangers including performance data, materials, dimensions, weights, and installation data. Submit Manufacturer's Data Report for Pressure Vessels, Form U-1, as required by provisions of ASME Code Rules.

Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loadings, required clearances, and methods of assembly of components.

Record Drawings: At project closeout, submit Record Drawings of installed systems products in accordance with requirements of Division 1.

Maintenance Data: Submit maintenance data and parts list for each heat exchanger including "trouble-shooting" maintenance guide. Include this data and product data in maintenance manual; in accordance with requirements of Division 1.

1.3 DELIVERY, STORAGE, AND HANDLING

Handle heat exchangers carefully to prevent damage, breaking, denting, and scoring. Do not install damaged units or components; replace with new.

Store heat exchangers in clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.

Comply with manufacturer's rigging and installation instructions for unloading heat exchangers, and moving them to final location.

PART 2 - PRODUCTS

2.0 MANUFACTURERS

Manufacturer: Subject to compliance with requirements, provide products by one of the following:

Water-to-Water Plate and Frame Heat Exchangers:

Alpha Laval
Paul Mueller Co.
Tranter, Inc.
Taco, Inc.
Armstrong

2.1 WATER-TO-WATER PLATE AND FRAME HEAT EXCHANGER

This Contractor shall provide plate and frame heat exchanger of capacity as scheduled and where shown on the drawings with embossed heat transfer plates, perimeter gaskets, guide rails, and frames and compression bolts.

Units shall be ASME rated for 125 psig operating pressure, 300 degree F (149 degree C) maximum temperature, have a heat transfer area as scheduled on the drawing.

Frame shall be carbon steel with baked epoxy enamel paint, side bolts and shroud. Plates shall be Type 304 stainless steel.

Gaskets shall be nitrile rubber.

Nozzles shall be 150 lb. ASA rated loose flange type, of the size called for on the Drawings.

Heat exchanger shall be AHRI-400 certified.

PART 3 - EXECUTION

3.0 INSPECTION

Examine areas and conditions under which heat exchangers are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.1 INSTALLATION OF WATER-TO-WATER PLATE AND FRAME HEAT EXCHANGERS

General: Comply with water-to-water plate and frame heat exchanger manufacturer's instructions for installation.

Install water-to-water plate and frame heat exchangers, piping and accessories in accordance with manufacturer's instructions.

3.2 ADJUSTING AND CLEANING

Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

3.3 SPARE PARTS

General: Furnish to Owner, with receipt, one (1) spare gasket for each flanged connection for each heat exchanger.

END OF SECTION 23 57 00

SECTION 23 64 23
SCROLL CHILLERS

PART 1 - GENERAL

1.0 RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 and 23 Specification sections, apply to work of this section.

1.1 REFRIGERANTS

All refrigerants used for each condensing unit shall be on the latest EPA list of approved refrigerants and environmentally friendly.

No CFC based refrigerants shall be used.

1.2 DESCRIPTION OF WORK

Extent of Scroll Liquid Chiller Work required by this section is indicated on drawings and schedules, and by requirements of this section.

Types of Scroll Liquid Chillers specified in this section include the following:
Packaged Outdoor Air Cooled

Refer to other Division 23 sections for concrete pads, piping, piping specialties, pumps, and valves, which are required external to chillers for installation.

Refer to other Division 23 sections for field-installed automatic temperature controls required in conjunction with chillers.

Refer to Division 23 section "Vibration Control" for vibration control work required in connection with chillers.

Manufacturers shall be responsible to provide any information to the contractor prior to bidding which may impact the installed cost for the Contractor including but not limited to:

Power wiring sizing quantity and type of conductors
Control power
Auxiliary piping connections

1.3 QUALITY ASSURANCE

Manufacturers: Firms regularly engaged in manufacture of chillers, of types and capacities required, whose products have been in satisfactory use in similar service for not less than five (5) years.

Installer's Qualifications: Firm with at least five (5) years of successful installation experience with projects utilizing chillers similar to those required for this project.

ASHRAE Compliance: Construct and install chillers in accordance with ASHRAE Standard 15, "Safety Code for Mechanical Refrigeration". Provide Energy Efficiency Ratio (EER) for chillers not less than prescribed by ASHRAE Standard 90A, "Energy Conservation in New Building Design".

NEC Compliance: Comply with applicable NEC requirements pertaining to electrical power and control wiring for construction and installation of chillers.

ANSI/ASHRAE Compliance: Comply with ANSI 15 safety code requirements pertaining to unit construction of chillers.

ASME Compliance: Construct and test air-cooled liquid chiller in accordance with ASME Boiler and Pressure Vessel Code, Section 8.

NEMA Compliance: Provide high-efficiency motors for chillers which comply with NEMA Standards Pub./No.'s MG 1, 2, 3, 10, and 11.

ANSI/UL 984: Safety standards for hermetic motor compressors.

1.4 SUBMITTALS

Product Data: Submit manufacturer's technical product data, including rated capacities for chillers indicated, sound power levels, weights (shipping, installed, and operating), furnished specialties and accessories; and rigging, installation, and start-up instructions.

Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loadings, required clearances, methods of assembly of components, and location and size of each field-connection.

Provide templates for anchor bolt placement in concrete pad. Deliver templates to concrete Installer so work by others is not delayed.

Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to units. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

Record Drawings: At project closeout, submit record drawings of installed systems products in accordance with requirements of Division 1.

Maintenance Data: Submit maintenance data and parts list for each chiller, control, and accessory; including "trouble-shooting" maintenance guide. Include this data and product data in maintenance manual; in accordance with requirements of Division 1.

1.5 DELIVERY, STORAGE, AND HANDLING

Handle chillers and components properly to prevent damage, breaking, denting and scoring. Do not install damaged reciprocating chillers or components; replace with new. Comply with manufacturer's rigging and installation instructions for unloading chillers, and transporting them to final location.

Store reciprocating chiller and components in clean dry space. Protect from weather, dirt, fumes, water, construction debris, and physical damage. Storage temperatures for unit controls are not to exceed 185 degree F (85 degree C).

1.6 WARRANTY

Provide five (5) year motor/compressor replacement warranty in addition to the one (1) year warranty required under Division 23. Warranty shall include parts and labor.

PART 2 - PRODUCTS

2.0 MANUFACTURERS

Manufacturers: Subject to compliance with requirements, provide products by one of the following:

Outdoor Air-Cooled Scroll Liquid Chillers:

Trane Company
Daikin
York/Johnson Controls
Multistack

2.1 OUTDOOR AIR-COOLED SCROLL LIQUID CHILLERS

General: Provide factory-assembled and tested outdoor air-cooled liquid chillers as indicated, consisting of compressors, evaporator, condensers, thermal expansion valves, and control panels. Provide capacity and electrical characteristics as scheduled.

Refrigerant: Provide full operating charge of refrigerant and oil.

Housing: Housing shall be minimum 14 gauge welded galvanized steel frame with 14 and 16 gauge galvanized steel panels and access doors with corrosion protection coating, and exterior finish. Provide removable panels and/or access doors for inspection and access to internal parts and components.

Evaporator: Provide shell-and-tube design with seamless copper tubes roller expanded into tube sheets. Design, test, and stamp for refrigerant side working pressure of 650 PSIG minimum, and water side working pressure of 150 PSIG minimum, in accordance with ASME Pressure Vessel Code. Provide one (1) water pass with series of internal baffles. Insulate with 3/4-inch minimum flexible unicellular insulation with maximum K-value of 0.26. Provide water drain connection and bulb wells for temperature controller and low-temperature cutout.

Heater Tapes: Provide electrical resistance heater tape on evaporator to protect against freezing at -20 degree F (-29 degree C) ambient at no-flow condition.
Multiple-Compressor Units: Provide independent multiple refrigerant circuits with gasketed evaporator heads.

Condenser: Construct coils with configurated aluminum fins mechanically bonded to seamless copper tubing. Provide integral subcooling circuit with liquid accumulators. Leak test coils with air under water at 425 PSIG air pressure. Provide protective grilles over exposed coil faces.

Multiple-Compressor Units: Provide multiple circuited condenser coils.
Condenser Fans: Provide propeller fans, direct driven, draw-through design, statically and dynamically balanced. Provide permanently lubricated ball-bearing motors with overload protection. Provide protective grille over air discharge.

Compressors: Provide direct drive 3600 RPM, multi-cylinder scroll compressors with crankcase heater; either semi-hermetic or hermetic, with a minimum four (4) steps of capacity control. Mount compressors on vibration isolators within chiller housing.

Lubrication: Provide oil pump, oil filter, oil level sight glass, and oil charging valve.

Capacity Modulation: Provide step-control by means compressor staging, from return water temperature.

Refrigerant Circuit: Provide for each refrigerant circuit the following:
Provide multiple independent separate refrigerant circuits with a minimum of two (2).

- Liquid line solenoid valve.
- Filter dryer.
- Liquid line sight glass and moisture indicator.
- Thermal expansion valve.
- Insulated suction line.
- Suction and discharge valves.

Controls and Control Panels:

Locate on the chiller, factory wired NEMA 3R unit control panel, containing both a controls section as well as a starter section.
Provide the following devices in starter section:

- Factory wired single point power hook-up.
- Three-phase solid-state overload protection.
- Customer wired grounding lug.
- Control power transformer with primary and secondary fused protection.
- Factory wired across-the-line starter with solid state fixed OFF/ON timers on all compressor motors.
- Non-recycling compressor overloads.
- Phase loss/reversal/imbalance and undervoltage monitor on main power connection. A 15 percent under voltage condition for 4-5 seconds will shut unit OFF and require manual reset.

Provide the following devices in the control panel:

- Compressor run lights.
- System start-stop switch.
- Low pressure lockout lights.
- Terminal strips.
- Central micro-processor
  - Leaving fluid setpoint
  - Delta T setpoint
  - Number of stages
- Control power fuses.
- Motor protection/oil failure controller.
- Indicating lights for load limit.
- Stages of unit unloading.

Provide the following safety controls arranged so that operating any one (1) will shutdown machine and require manual reset:

- Low chilled water temperature switch.
- High discharge pressure switch for each circuit.
- Low suction pressure switch for each circuit.
- Oil pressure switch.
- Current overload.
- Motor temperature.

Provide the following safety controls so there is automatic shutdown of the machine with automatic reset:

- Over voltage.

Under voltage.
Phase reversal.
Chilled water flow interlock.

Provide the following operating controls:

Multi-step chilled water temperature controller which cycles compressor.
Five-minute OFF timer prevents compressor from short cycling.
Across-the-line solid state start timer.
Provide automatic circuit-to-circuit lead-lag capability to allow for equal run time per compressor.
Periodic pump-out timer to pump down on chilled water flow and high evaporator refrigerant pressure.
Load limit thermostat to limit compressor loading on high return water temperature.
Power supply monitor to protect unit by stopping compressor on phase loss, phase reversal, incorrect phase sequence, and low voltage.
Cycle counter and operating hour meter.

Provide readout for suction and discharge refrigerant pressures, and oil pressures for each compressor.

Accessories: Provide the following accessories:

Hot gas bypass valve, factory-piped and wired.
Load limit thermostat, if required.
Vapor-proof chilled water flow switch.
Suction and discharge gauges.

Vibration Isolators of the following type:

Spring isolators.
Equipment rails and vertically-restrained spring isolators.
Fabricated equipment base and spring isolators.

Copper condenser fins.

PART 3 - EXECUTION

3.0 INSPECTION

Installer must examine areas and conditions under which reciprocating chillers are to be installed and notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.1 INSTALLATION OF SCROLL CHILLERS

General: Install reciprocating chillers in accordance with manufacturer's written instructions. Install units plumb and level, firmly anchored in locations indicated; maintain manufacturer's recommended clearances.

Support: Install floor-mounted units on reinforced concrete pad. Furnish anchor bolts which are to be inserted in concrete pad to Concrete Installer.

Support: Install roof-mounted units on structural steel mechanical equipment stand. Anchor unit to stand with removable type fasteners.

Construct mechanical equipment stand as indicated, and in accordance with NRCA Handbook of Accepted Roofing Knowledge, Detail "N".
Mechanical Equipment Stand is specified in Division 5; not work of this section.

Chilled Water Piping: Refer to Division 23. Connect inlet to evaporator with controller bulb well, shutoff valve, thermometer, strainer, flow switch, flexible pipe connector, drain valve, pressure gauge, and union or flange. Connect outlet to evaporator with shutoff valve, balancing cock, flow meter, thermometer, flexible pipe connection, pressure gauge, drain valve, and union or flange.

Condenser Water Piping: Refer to Division 23. Provide flanged or union connections to condenser, arranged to allow removal of condenser heads. Connect inlet to condenser with shutoff valve, thermometer, plugged tee, pressure gauge, flexible pipe connector, and union or flange. Connect outlet to condenser with shutoff valve, flow meter, thermometer, drain valves and shutoff valve, strainer, plugged tee, flexible pipe connector, and union or flange.

Refrigerant Piping: Refer to Division 23. Provide piping between chiller and condenser as indicated, and in accordance with installation instructions of both chiller and condenser manufacturers.

Relief Piping: Provide relief piping as indicated from refrigerant pressure relief rupture disc on chiller to outside building atmosphere; size piping as recommended by chiller manufacturer, and terminate with gooseneck facing down.

Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.

Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to manufacturer and equipment Installer.

Control: Furnish field-installed automatic temperature control requirements to Control Installer.

Start-up: Chiller start-up shall be by factory authorized service representative in accordance with manufacturer's recommendations. Test controls and demonstrate compliance with requirements. Replace damaged, or malfunctioning, controls and equipment and retest.

Do not place chillers in sustained operation prior to initial balancing of mechanical systems which interface with the reciprocating chillers.

3.2 TRAINING OF OWNER'S PERSONNEL

Provide services of manufacturer's technical representative for two (2) 8-hour days to instruct Owner's personnel in operation and maintenance of reciprocating chillers.

Schedule training with Owner, provide at least seven (7) day notice to Contractor and Engineer of training date.

END OF SECTION 23 64 23

SECTION 23 72 00

ENERGY RECOVERY UNITS

PART 1 - GENERAL

1.0 RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.1 DESCRIPTION OF WORK

Extent of Energy Recovery Units Work required by this section is indicated on drawings and schedules, and by requirements of this section.

Types of Energy Recovery Units specified in this section include the following:

Packaged Energy Recovery Units

Refer to other Division 23 sections for piping; specialties; pumps; ductwork; temperature controls; testing and balancing; required external to energy recovery units for installation; not work of this section.

Refer to Division 26 sections for the following work; not work of this section.

Power supply wiring from power source to power connection on energy recovery units. Include starters, disconnects, and required electrical devices, except where specified as furnished, or factory-installed, by manufacturer.
Interlock wiring between electrically-operated equipment units; and between equipment and field-installed control devices.

Interlock wiring specified as factory-installed is work of this section.

Provide the following Electrical Work as work of this section, complying with requirements of Division 26 sections:

Control wiring between field-installed controls, indicating devices, and energy recovery unit control panels.

Control wiring specified as work of Division 23 for Automatic Temperature Controls is work of that section.

1.2 QUALITY ASSURANCE

Manufacturer's Qualifications: Firms regularly engaged in manufacture of energy recovery units, of types and capacities required, whose products have been in satisfactory use in similar service for not less than five (5) years.

Codes and Standards:

ASHRAE Compliance: Provide capacity ratings for energy recovery devices in accordance with ASHRAE 84 "Methods of Testing Air-to-Air Heat Exchangers".
NRCA Compliance: Provide roof curbs for roof mounted equipment constructed in accordance with recommendations of NRCA.
ARI Compliance: Test and rate energy recovery units in accordance with ARI 1060 "Standard for Air-to-Air Heat Recovery Equipment".

ASHRAE Compliance: Design, construct, and install heat pipe heat exchangers in accordance with ASHRAE 15 "Safety Code for Mechanical Refrigeration".
NFPA Compliance: Construct and install energy recovery units incorporating electrical equipment in accordance with NFPA 70 "National Electrical Code".
UL Labels: Provide energy recovery units ancillary electrical components which have been listed and labeled by UL.

1.3 SUBMITTALS

Product Data: Submit manufacturer's technical product data, including rated capacities of selected model clearly indicated, weights (shipping, installed, and operating), furnished specialties and accessories; and installation and start-up instructions.

Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loadings, required clearances, and methods of assembly of components.

Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to units. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

Record Drawings: At project closeout, submit record drawings of installed systems products, in accordance with requirements of Division 1.

Maintenance Data: Submit maintenance data and parts list for each energy recovery unit, control, and accessory; including "trouble-shooting" maintenance guide. Include this data, product data, shop drawings, and wiring diagrams in maintenance manual; in accordance with requirements of Division 1.

1.4 DELIVERY, STORAGE, AND HANDLING

Handle energy recovery units and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged units or components; replace with new.

Store energy recovery units and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.

Comply with manufacturer's rigging and installation instructions for unloading energy recovery units, and moving them to final location.

PART 2 - PRODUCTS

2.0 MANUFACTURERS

Manufacturer: Subject to compliance with requirements, provide products by one of the following:

Energy Recovery Units:

Annex Air
Haakon
Energy Labs
Innovent

2.1 PACKAGED ENERGY RECOVERY UNITS

General: Provide factory-fabricated and factory-tested double wall, fully insulated air handling units as indicated, of sizes and capacities as scheduled, and as specified herein.

Provide variable air volume units consisting of fan sections, coil sections, and filter sections.
Provide reinforced points of support for setting units.
Provide sloped drain pan, located under all coil sections extensive enough to catch condensate leaving coil at highest catalogued face velocity. Provide at least one (1) drain connection at low point in drain pan in piping vestibule.
Cover casing and frame with protective finish on both sides.
Provide lights in accessible sections with wire guards, factory wired to switch mounted on casing exterior.

Provide base rail capable of supporting the unit.

Housing: Construct of heavy-gauge galvanized steel panels fastened to structural steel or formed galvanized steel internal frame, gasketed and caulked weather tight. Provide pitched top to shed water and overhang sides by 4-inch minimum. Provide waterproof floor with upturned seams and collars at all penetrations. Finish housing with manufacturer's standard paint finish. Provide lifting lugs.

Housings shall be fully insulated to R-12 to comply with requirements of the IECC.
Provide access to internal components by access doors, double wall insulated, one (1) side hinged and minimum of two (2) cam latches operated from either side.
Provide louvers for air inlet and exhaust, stormproof type, with gravity backdraft damper equipped with blade seals for exhaust, and spring-return 2-position motor-operated damper with blade seals for supply.
Provide roof curb to support unit. Construct in accordance with NRCA recommendations.

Heat Wheel: Provide heat wheel within housing, with rotor media constructed of corrugated aluminum. Provide bacteriostatic, non-toxic, non-corrosive desiccant coating. Construct media for passing solids up to 300 microns, and to limit cross contamination between air steams to 0.04 percent by volume of exhaust air.

Control: Rotate wheel at variable speed for constant supply air temperature, controlled by discharge thermostat, summer-winter changeover thermostat, and SCR controller. Provide control panel containing On-Off Switch, Auto-Manual Switch, manual speed adjustment, and indicating light.
Alarm: Provide alarm device to signal rotation failure, with set of contacts for alarm circuit field wiring.

Fans: Provide direct drive supply and exhaust fans with TEFC motors of scheduled capacity and design, isolated from unit housing with spring isolation base and flexible duct connections.

Filters: Provide 2-inch thick disposable filters in galvanized steel frame, on upstream side of wheel in both supply and exhaust air streams.

Heating and Cooling Coils: Provide heating and cooling coils, of type and capacity as scheduled and as specified.

Outside Air Measurement: Provide factory mounted airflow measurement station in the outside air opening. The airflow measuring station shall measure from 15% to 100% of unit airflow and shall automatically adjust for pressure and temperature variations.

Piping and Wiring: Provide chase within housing for piping and electrical conduits. Factory-pipe coils and factory-wire motors and controls, so only external connections are required.

Hoods:

Fresh air (and exhaust air) hoods shall be provided complete with 0.5 in x 0.5 in birdscreen and finished to match the color of the units. Hoods shall be of 16 gauge galvanized steel construction, finished to match the unit. Provide continuous rain gutters around the perimeter of the hood with drain connections. Hoods shall be sized for maximum of 500fpm on the free area of the inlet.

PART 3 - EXECUTION

3.0 INSPECTION

Examine areas and conditions under which energy recovery units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.1 INSTALLATION

Install energy recovery units where indicated, in accordance with equipment manufacturer's written instructions, and with recognized industry practices to ensure that units comply with requirements and serve intended purposes.

Access: Provide access space around air handling units for service as indicated, but in no case less than that recommended by manufacturer.

Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.

Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.

Piping Connections: Refer to Division 23 HVAC sections. Provide piping, valves, accessories, gauges, supports, and as indicated.

Provide shutoff valves, balancing valves, unions, thermometers (supply and return), P and T taps (supply and return) and other accessories on all piping connections.

Duct Connections: Refer to Division 23 Air Distribution sections. Provide ductwork, accessories as indicated.

Provide flexible connections on all duct connections.
Grounding: Provide positive equipment ground for air handling unit components.

3.2 FIELD QUALITY CONTROL

Testing: Upon completion of installation of air handling units, provide factory trained start-up support to the installing contractor. Mechanical Contractor shall perform actual start-up and operate equipment to demonstrate capability and compliance with requirements. Field correct malfunctioning units if required, then retest to demonstrate compliance with these specifications.

Upon completion of installation of energy recovery units, and after air-side and water-side balancing has been completed, test units to ascertain percent effectiveness of heat transfer device. Adjust units for maximum effectiveness.

Furnish test report, similar to SMACNA Form, ER-1-78, include report in each copy of maintenance manual.

3.3 TRAINING

Schedule a minimum of four (4) hours of training with Owner. The manufacturer's representative, and the Division 23 Contractor shall be present. The training shall be coordinated by the Division 23 Contractor and the Owner in conjunction with the other mechanical equipment on the project.

Training:

Train the Owner's maintenance personnel on start-up and shutdown procedures, troubleshooting procedures, and servicing and preventative maintenance schedules and procedures. Review with the Owner's personnel, the contents of the Operating and Maintenance manual.

Schedule training with Owner through the Architect/Engineer with at least seven (7) days prior notice.

3.4 EXTRA STOCK

Provide one (1) complete extra set of filters for each filter bank in energy recovery units. Install new filters at completion of energy recovery system work, and prior to testing, adjusting, and balancing work. Obtain receipt from Owner that new filters have been installed.

Provide one (1) spare set of belts for each belt-driven fan in energy recovery units. Obtain receipt from Owner that belts have been received.

END OF SECTION 23 72 00

SECTION 23 74 14

ROOFTOP HEATING & COOLING UNITS

PART 1 - GENERAL

1.0 RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.1 DESCRIPTION OF WORK

Extent of Packaged Rooftop Heating and Cooling Units Work required by this section is indicated on drawings and schedules, and by requirements of this section.

Refer to other Division 23 sections for metal ductwork, air devices, automatic temperature controls not factory-installed, and required for conjunction with packaged heating and cooling units; not work of this section.

Electrical Work: Refer to Division 23 section "Electrical Provisions of Mechanical Work" for requirements.

1.2 REFRIGERANTS

All refrigerants used for each condensing unit shall be on the latest EPA list of approved refrigerants and environmentally friendly.

No CFC or HCFC based refrigerants shall be used.

1.3 SUBMITTALS

Product Data: Submit manufacturer's technical product data, including rated capacities of selected model clearly indicated, dimensions, required clearances, sound power characteristics, weights, furnished specialties and accessories; and installation and start-up instructions.

Shop Drawings:

Submit shop drawings detailing the manufacturer's electrical requirements for power supply wiring for rooftop heating and cooling units. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
Submit shop drawings detailing the mounting, securing, and flashing of the roof curb to the roof structure. Indicate coordinating requirements with roof membrane system.

Samples for Initial Selection: For units with factory-applied color finishes.
Record Drawings: At project closeout, submit record drawings of installed systems products in accordance with requirements of Division 1. Markup Drawing Schedule for installed equipment data.

Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

Maintenance Data: Submit maintenance data and parts list for each rooftop heating and cooling unit, control, and accessory, including "trouble-shooting" maintenance guide. Include this data in operation and maintenance manual; in accordance with requirements of Division 1.

1.4 QUALITY ASSURANCE

Manufacturer's Qualifications: Firms regularly engaged in manufacture of rooftop heating and cooling units, of types and capacities required, whose products have been in satisfactory use in similar service for not less than five (5) years.

Codes and Standards:

Gas-fired furnace section construction shall be in accordance with CSA Safety Standards. Furnace section shall bear the CSA label.
Testing and rating of rooftop units of 135,000 BTU/Hr capacity or over shall be in accordance with ARI 360 "Standard for Commercial and Industrial Unitary Air-Conditioning Equipment".
Refrigerating system construction of rooftop units shall be in accordance with ASHRAE 15 "Safety Code for Mechanical Refrigeration".
Energy Efficiency Ratio (EER) of rooftop units shall be equal to or greater than prescribed by ASHRAE 90.1 A "Energy Conservation in New Building Design".
Provide rooftop units which are UL listed and labeled.
Rooftop units shall be designed, manufactured, and tested in accordance with UL requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

Handle units and components carefully to prevent damage. Replace damaged rooftop units or components with new.

Store units and components in clean dry place, off the ground, and protect from weather, water, and physical damage.

Rig units to comply with manufacturer's rigging and installation instructions for unloading units, and moving them to final location.

1.6 SCHEDULING AND SEQUENCING

Coordinate installation of roof mounting curb with roof structure.
Coordinate roof opening locations and for mechanical and electrical connections.

1.7 SPECIAL WARRANTY

Warranty on Compressor: Provide written warranty, signed by manufacturer, agreeing to replace/repair, within warranty period, compressors with inadequate and defective materials and workmanship, including leakage, breakage, improper assembly, or failure to perform as required; provided manufacturer's instructions for handling, installing, protecting, and maintaining units have been adhered to during warranty period. Replacement is limited to component replacement only, and does not include labor for removal and reinstallation.

Warranty Period: Five (5) years from date of substantial completion.

Warranty for Labor Coverage of Defective Parts: Provide written manufacturer’s warranty to provide factory technician for replacement of defective parts for one year after substantial completion.

Warranty period: One (1) year from date of substantial completion.

1.8 EXTRA MATERIALS

Extra Materials: Furnish to Owner, with receipt, the following spare parts for each rooftop heating and cooling unit:

One (1) set of filters for each unit.

PART 2 - PRODUCTS

2.0 MANUFACTURERS

Manufacturers: Subject to compliance with requirements, provide products by one of the following:

Rooftop Units:

Trane
Johnson/York; Division of York International (requires Owner approval)
Innovent (requires Owner approval)

2.1 ROOFTOP UNITS 50 TONS AND LARGER

General Description: Rooftop unit shall be factory-assembled and tested, designed for roof or slab installation and, consisting of compressors, condensers, evaporator coils, condenser fans, and evaporator fan array, return fan array, refrigeration and temperature controls, filters, and dampers. Capacities and electrical characteristics are scheduled on the Drawings.

Casing shall have exterior panels of zinc coated galvanized steel, phosphatized, and painted with factory standard finish for outdoor units. All panels, doors, walls, uprights, floor panels and roofing shall be one-inch thick; foam injected insulation. Units are specifically designed for outdoor installation. Provide access doors that are easily and quickly operable for inspection and access to internal parts.

Provide reinforced points of support for either setting or hanging units.
Base Rail: The unit shall include an integral design base rail with lifting points clearly marked and visible on the base rail and a 1-1/4" FPT connection for condensate drainage on each side of the unit. The unit base shall be designed with a recessed curb mounting location. The recessed curb-mounting surface shall provide a continuous surface for field application of curb gasketing to create a weather tight seal between the curb and unit.
Provide double sloped drain pan, located under coil section. Provide at least one (1) drain connection at low point in drain pan.
Provide lights in accessible sections with wire guards, factory wired to switch mounted on casing exterior.
Units shall be provided with double wall construction throughout. The walls shall be 1-inch. The panels shall be fully insulated, R-8 minimum.
The access doors shall be of double wall construction. Access doors shall be provided in the fan, coil, filter and inlet sections of the unit on both sides of the unit. Single, exterior mounted, height and tension adjustable handles shall be provided on each access door.
The doors shall be hinged and shall be fully gasketed with neoprene material.
Outdoor Enclosures: Provide weather resistant, outdoor type enclosure. Pitch tops of casings for water run-off. Provide gaskets for assembled joints, caulk weather-tight.
Insulation: Insulate unit casing, throughout. Insulation shall be R-8 minimum.
Rapid Restart functionality: Upon loss of power and changeover to backup generator power, the system shall provide full cooling within 120 seconds after power is restored. Rapid Restart capability shall be fully integrated into the unit controller and control logic. Field installed solutions shall be fully tested and documented and coordinated with the generator vendor. Demonstrate compliance with the commissioning agent and Owner's representative.

Roof Curbs: Manufacturer's standard construction, insulated and having corrosive protective coating, complete with factory-installed wood nailer and drain nipple. Construction shall be in accordance with NRCA Standards.

Supply and Return Fan Sections: Provide plenum fans in an array, matrix, or fan wall configuration. All fan arrays shall be specifically designed and suitable for class of service indicated. Provide direct-drive fans. Design fan shafts so as not to pass through first critical speed when unit comes up to rated RPM. Provide permanently lubricated fan bearings. Statically and dynamically balance fan assemblies in fan housing after final assembly.

Fan bearings shall be rated for a minimum of L10 life 200,000 hours.
Fan and fan motor shall be internally mounted and isolated on a full width isolator support channel using 2-inch springs with optional seismic restraints.
Provide one (1) VFD per two fans in a fan array to provide redundancy. Arrange in a checker board pattern.
Each fan in a fan array shall be provided with a low pressure drop backdraft damper that will automatically close in the event of failure of the fan or motor.

Coils:

General: Aluminum plate fin and seamless copper tube type. Fins shall have collars drawn, belled and firmly bonded to the tubes by means of mechanical expansion of the tubes. No soldering or tinning shall be used in the bonding process. Coils shall have a galvanized steel casing. Coils shall be mounted in the coil casing with same end connections accessible for service. Coils shall be removable from the unit through the roof or through the side wall of the unit. Coil section shall be completely insulated.
Refrigerant Cooling Coils: Have an equalizing type vertical distributor to ensure each coil circuit receives the same amount of refrigerant. Coils shall be proof (450 psig) and leak (300 psig) tested with air pressure under water, then cleaned, dehydrated, and sealed with a holding charge of nitrogen. Coils shall be inter-circuited to maintain active coil face area at part load conditions.

Provide water detection device (safe-t-switch or similar) in the drain pan to shut unit down if primary drain becomes blocked.
Gas Heating Section:

Heat Exchangers: Manufacturer's standard construction for gas-fired heat exchangers and burners. Provide single gas connection.
Controls:

Redundant gas valves;
Intermittent pilot ignition;
Electronic spark ignition system;
High limit cutout;
Forced draft proving switch;
Flame roll-out switch.

Condenser Fans: Condenser fans shall be matched up with compressors to optimize system control. Condenser fans shall be propeller type, directly driven by permanently lubricated TEAO motor with built-in current and thermal overload protection.

Condenser Section:

Condenser Coil: Microchannel condenser coils shall be constructed of parallel flow aluminum alloy tubes metallurgically brazed to enhanced aluminum alloy fins. Coils are configured in a V-bank configuration, with individual flat coils rotated from the vertical plane for protection from hail damage for each condensing circuit. Condensing coils shall have a subcooler for more efficient, stable operation. Condenser coil shall be factory pressure tested to 650 PSIG.
Low Ambient: Compressors shall operate down to 32°F by monitoring the refrigeration system discharge pressure and adjusting condenser airflow to maintain the proper head pressure to protect compressor operation. Refrigerant pressure transducers shall be included and provide the discharge pressure on the single packaged unit control display.
Compressors: Units shall use industrial-duty hermetic scroll compressors, piped and charged with oil and HFC-410A refrigerant. Compressors shall have an enlarged liquid carrying capacity to withstand rugged operating conditions. Compressor frame shall be cast iron, with cast iron fixed and orbiting scrolls. Each compressor shall feature a solid state protection module, designed to protect the compressor from over- temperature and over-current conditions. Compressors shall be vibration-isolated from the unit and installed in an easily accessible area of the unit. All compressor-to-pipe connections shall be brazed to minimize potential for leaks. Each compressor shall include a replaceable suction screen, discharge line check valve, and oil sight glass.

Provide variable speed compressors capable of modulation from 25 Hz to 100 Hz allowing the entire unit to fully modulate from 15% capacity to 100% capacity. DAT controlled units shall be capable of maintaining DAT to +/- 1 Deg F over the range. Variable speed compressor control shall be integral to the unit.

In-Line Refrigerant Driers: Refrigerant piping includes check valves, thermal expansion valves with replaceable thermostatic elements, high and low pressure switches, anti-recycling timing device to prevent compressor restart for five minutes after shutdown.
Freezestats shall be provided to prevent coil freeze up and reduce the risk of liquid flood-back to the compressor.
Condenser enclosure: The condenser section shall be enclosed by a Louvered Panel condenser enclosure on the three exposed sides.

Filter Section: Provide filter section with hinged access doors at each end. Provide racks to receive filters in a flat pattern.

Pre-filter rack section:

Provide 2 inch MERV 9 prefilter and 12 inch deep cartridge type MERV 14 filters mounted in a 7/8” nominal thickness header frame.

Final Filter rack section: Provide 12-inch deep HEPA final filter. Locate downstream of gas heating section.

Economizer Section.

Modulating Economizer: The economizer segment shall be designed to use outside air for cooling and ventilation and provide a means of exhausting air from the air-handling unit. The segment shall consist of parallel acting low-leak dampers. The return air, outside air and exhaust air dampers shall be sized for 100% of nominal unit airflow. The exhaust air damper assembly shall have a factory-assembled rain hood. The rain hood shall have a drip-lip the full width of the hood to channel moisture away from the air being drawn into the unit.

Outside Air Measurement: Provide factory mounted airflow measurement station in the outside air opening. The airflow measuring station shall measure from 15% to 100% of unit airflow and shall automatically adjust for pressure and temperature variations.
Building Pressure Control: Provide a differential pressure control system. The system shall modulate the exhaust damper in the return fan section to maintain the space setpoint pressure.

Electrical: Units shall have single point power connection.

Unit shall be provided with a 65.000 amp SCCR rating from the factory. The unit shall include an approved UL listing and shall adhere to all UL regulations. Modifications in the field in an attempt to comply with the SCCR rating is not acceptable. Supplier bears all responsibility for all costs associated with failure to comply.

Temperature Control: Factory-installed, DDC control with BACnet interface.

Refer also to Sequence of Operation on the drawings.
Enclosure: Unit shall be shipped complete with factory configured, installed, wired and tested single packaged unit controller housed in a rain and dust tight NEMA 3R/12 (IP55) powder painted steel cabinet with hinged, latched, and gasket sealed door.
Compressor Capacity Modulation: Unit shall include up to six compressors of varying size to provide 14 to 100% cooling capacity control with no capacity steps or gaps over the range, during normal operation. The compressor sequence of operation shall reduce typical temperature change to less than 1°F at the unit discharge at full design air flow. Unit shall not require hot gas bypass and the inherent energy usage it requires to properly operate the unit. Upon entering cooling mode from other modes, the unit controller will estimate the cooling requirement and match it closely to the capacity in order to reduce the time required to satisfy the cooling requirements. After the initial calculation, the unit controller will add or reduce stage(s) as necessary to establish a balance between the unit capacity and the space cooling load.
Basic Controls: Control shall include automatic start, stop, operating, protection sequences across the range of scheduled conditions and transients. The single packaged unit controller shall provide automatic control of compressor start/stop, energy saver delay and anti-recycle timers, condenser fans, and unit alarms. Automatic reset to normal operation after power failure. Software stored in non-volatile memory, with programmed setpoints retained in lithium battery backed real time clock (RTC) memory for minimum 5 years. An eighty character liquid crystal display shall be provided to show all descriptions and numeric data in English (or Metric) units. A sealed, membrane style keypad, with no less than 36 keys, shall be used to navigate the controller and enter data.
Diagnostics: Upon startup of the controller, it shall run through a self-diagnostic check to verify proper operation and sequence loading. The single packaged unit controller shall continually monitor all input and output points on the controller to maintain proper operation. The unit shall continue to operate in a trouble mode or shut down as necessary to prevent an unsafe condition for the building occupants, or to prevent damage to the equipment. In the event of a unit shutdown or alarm, the operating conditions, date and time shall be stored in the shutdown history to facilitate service and troubleshooting. A minimum of ten (10) Error Histories shall be recorded.

BAS Communications

BACnet MSTP (RS-485): The unit shall include BACnet communications directly from the unit controller. Equipment that is not native BACnet at the unit control board shall include any necessary interface or translator device factory-mounted and wired within the unit. A control points list, BIBBs and PICS statement shall be provided by the manufacturer to facilitate communications programming with the building automation system. Programming, establishing communications and commissioning shall be the responsibility of the installing controls contractor. Start-up assistance and support may be purchased from the manufacturer.
Generic Hard-Wired BAS Interface: An interface shall be provided that provides an interface to any building automation system via hardwired connections.

Accessories:

Provide bird screen around openings into unit, especially the condenser section. Bird screens can be field or factory installed.
Full perimeter roof curb

PART 3 - EXECUTION

3.0 EXAMINATION

Examine areas and conditions under which rooftop units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.1 INSTALLATION

General: Install rooftop units in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.
Support: Install and secure roof curb to roof structure, in accordance with National Roofing Contractor's Association (NRCA) installation recommendations and shop drawings. Install and secure rooftop units on curbs and coordinate roof penetrations and flashing.
Electrical Connections: Refer to Division 26 for final connections to equipment and installation of loose shipped electrical components.

3.2 DEMONSTRATION

Start-Up Services:

Provide the services of a factory-authorized service representative to start-up rooftop units, in accordance with manufacturer's written start-up instructions. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

Operating and Maintenance Training:

Provide services of manufacturer's service representative to instruct Owner's personnel in operation and maintenance of rooftop units. Training shall include start-up and shutdown, servicing and preventative maintenance schedule and procedures, and troubleshooting procedures plus procedures for obtaining repair parts and technical assistance. Review operating and maintenance data contained in the Operating and Maintenance Manuals specified in Division 1.
Schedule training with Owner, provide at least seven (7) day prior notice to the Architect/Engineer.

END OF SECTION 23 74 14

SECTION 23 81 26

SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.0 RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.1 DESCRIPTION OF WORK

Section includes split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

Refer to other Division 23 sections for metal ductwork, air devices, automatic temperature controls not factory-installed, and required for conjunction with packaged heating and cooling units; not work of this section.

Electrical Work: Refer to Division 23 section "Electrical Provisions of Mechanical Work" for requirements.

1.2 REFRIGERANTS

All refrigerants used for each condensing unit shall be on the latest EPA list of approved refrigerants and environmentally friendly.

No CFC or HCFC based refrigerants shall be used.

1.3 SUBMITTALS

Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection. Clearly differentiate between portions of wiring that are factory-installed and portions that are to be field-installed.
Wiring Diagrams: For power, signal, and control wiring.

Samples for Initial Selection: For units with factory-applied color finishes.

Field quality-control reports.

Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

Warranty: Sample of special warranty.

Record Drawings: At project closeout, submit record drawings of installed systems products in accordance with requirements of Division 1.

1.4 QUALITY ASSURANCE

Manufacturer's Qualifications: Firms regularly engaged in manufacture of rooftop heating and cooling units, of types and capacities required, whose products have been in satisfactory use in similar service for not less than five (5) years.

Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

ASHRAE Compliance:

Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - " Procedures," and Section 7 - "Construction and System Start-Up."

ASHRAE/IESNA Compliance:

Applicable requirements in ASHRAE/IESNA 90.1-2009.
Energy Efficiency Ratio (EER) of equipment shall be equal to or greater than prescribed by ASHRAE 90.1 A, "Energy Conservation in New Building Design."

1.5 COORDINATION

Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete."

Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.6 WARRANTY

Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

Warranty Period:

For Compressor: One year(s) from date of Substantial Completion.
For Parts: One year(s) from date of Substantial Completion.
For Labor: One year(s) from date of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

Handle units and components carefully to prevent damage. Replace damaged units or components with new.

Store units and components in clean dry place, off the ground, and protect from weather, water, and physical damage.

Rig units to comply with manufacturer's rigging and installation instructions for unloading units, and moving them to final location.

1.8 EXTRA MATERIALS

Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

Filters: One set(s) for each air-handling unit.
Gaskets: One set(s) for each access door.
Fan Belts: One set(s) for each air-handling unit fan.

1.9 SCHEDULING AND SEQUENCING

Coordinate installation of roof mounting curb with roof structure.

Coordinate roof opening locations and for mechanical and electrical connections.

PART 2 - PRODUCTS

2.0 MANUFACTURERS

Manufacturers: Subject to compliance with requirements, provide products by one of the following:

Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or equal product by one of the following:

Mitsubishi Electric & Electronics USA, Inc.; HVAC Advanced Products Division.
SANYO North America Corporation; SANYO Fisher Company.
Toshiba
LG.
Panasonic
Daikin
Samsung

2.1 INDOOR UNITS 5 TONS OR LESS

Wall-Mounted, Evaporator-Fan Components:

Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.
Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 210/240.
Fan: Direct drive, centrifugal.
Fan Motors:

Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
Multitapped, multispeed with internal thermal protection and permanent lubrication.
Enclosure Type: Totally enclosed, fan cooled.
NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.
Mount unit-mounted disconnect switches on exterior of unit.

Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.
Condensate Drain Pans:

Fabricated with one percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.

Length: Extend drain pan downstream from leaving face.
Depth: A minimum of 1 inch deep.

Single-wall, stainless-steel sheet.
Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.

Minimum Connection Size: NPS 1.

Pan-Top Surface Coating: Asphaltic waterproofing compound.
Provide water detection device (safe-t-switch or similar) in the drain pan to shut unit down if primary drain becomes blocked.

Air Filtration Section:

Disposable Panel Filters:

Factory-fabricated, viscous-coated, flat-panel type.
Thickness: 1 inch.
Media: Interlaced glass fibers sprayed with nonflammable adhesive.
Frame: Galvanized steel, with metal grid on outlet side, steel rod grid on inlet side, and hinged; with pull and retaining handles.

2.2 OUTDOOR UNITS (5 TONS OR LESS)

Air-Cooled, Compressor-Condenser Components:

Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.

Inverter-driven compressor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
Refrigerant Charge: R-410A.
Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 210/240.

Fan: Aluminum-propeller type, directly connected to motor.
Motor: Permanently lubricated, with integral thermal-overload protection.
Low Ambient Kit: Permits operation down to minus 20 deg F.
Mounting Base: Polyethylene.

2.3 ACCESSORIES

Thermostat: Wired, to remotely control compressor and evaporator fan, with the following features:

Compressor time delay.
24-hour time control of system stop and start.
Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.
Fan-speed selection including auto setting.

Automatic-reset timer to prevent rapid cycling of compressor.

Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

Drain Hose: For condensate.

Integral condensate Pump.

2.4 CAPACITIES AND CHARACTERISTICS

See Equipment Schedule on Plans for capacities.

PART 3 - EXECUTION

3.0 INSTALLATION

Install units level and plumb.

Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

Install roof-mounted, compressor-condenser components on equipment supports specified in Division 07 Section "Roof Accessories." Anchor units to supports with removable, cadmium-plated fasteners.

Install compressor-condenser components on restrained, spring isolators with a minimum static deflection of 1 inch.

Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.1 CONNECTIONS

Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

3.2 FIELD QUALITY CONTROL

Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

Perform tests and inspections.

Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

Tests and Inspections:

Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

Remove and replace malfunctioning units and retest as specified above.

Prepare test and inspection reports.

3.3 STARTUP SERVICE

Perform startup service.

Complete installation and startup checks according to manufacturer's written instructions.

3.4 DEMONSTRATION

Train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 23 81 26

SECTION 23 82 00

TERMINAL HEAT UNITS

PART 1 - GENERAL

1.0 DESCRIPTION OF WORK

Extent of Terminal Unit Work is indicated on drawings and schedules, and by requirements of this section.

Types of Terminal Units required for project include the following:

Baseboard Radiation
Unit Heaters
Cabinet Unit Heaters

Refer to other Division 23 sections for piping; ductwork; testing, adjusting and balancing of terminal units; not work of this section.

Refer to Division 26 section for the following work; not work of this section.

Power supply wiring from power source to power connection on terminal units.
Provide the following electrical work as work of this section, complying with requirements of Division 26 sections:

Control wiring between field-installed controls, indicating devices, and terminal unit control panels.

Control wiring specified as work of Division 23 for Automatic Temperature Controls is work of that section.

Refer to other Division 23 sections for automatic temperature controls not factory installed, required in conjunction with terminal units; not work of this section.

1.1 QUALITY ASSURANCE

Manufacturer's Qualifications: Firms regularly engaged in manufacture of terminal units, of types and sizes required, whose products have been in satisfactory use in similar service for not less than five (5) years.

Codes and Standards:

I=B=R Compliance: Test and rate baseboard and finned tube radiation in accordance with I=B=R, provide published ratings bearing emblem of I=B=R.
ARI Compliance: Provide coil ratings in accordance with ARI Standard 410 "Forced-Circulation Air-Cooling and Air-Heating Coils".
ASHRAE Compliance: Test coils in accordance with ASHRAE Standard 33 "Methods of Testing Forced Circulation Air Cooling and Heating Coils".
ARI Compliance: Test and rate fan-coil units in accordance with ARI Standard 440 "Room Fan-Coil Air Conditioners".
UL Compliance: Construct and install fan-coil units in compliance with UL 883 "Safety Standards for Fan Coil Units and Room Fan Heater Units".
UL Compliance: Provide electrical components for terminal units which have been listed and labeled by UL.
ARI Compliance: Test and rate ventilators in accordance with ARI Standard 330 "Unit Ventilators".

Electric Heating Equipment: All equipment with a heating coil capacity exceeding a 48 amp rating shall have the heating elements subdivided and protected by an overcurrent protection device rated at not more than 60 amps. Equipment not exceeding 48 amps shall also have overcurrent protection. Overcurrent protection devices shall be factory wired and installed in accordance with the National Electric Code. All equipment shall be factory assembled and wired in accordance with the National Fire Protection Association and shall be listed by Underwriters' Laboratories.

1.2 SUBMITTALS

Product Data: Submit manufacturer's technical product data, for terminal units showing dimensions, capacities, ratings, performance characteristics, gauges and finishes of materials, and installation-startup instructions.

Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating terminal unit dimensions, weight loading, required clearances, construction details, field connection details and methods of assembly of components.

Include color chart for selection by Architect.

Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to terminal units. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

Record Drawings: At project closeout, submit record drawings of installed systems products in accordance with requirements of Division 1.

Maintenance Data: Submit maintenance instructions, including lubrication instructions, filter replacement, motor and drive replacement, control, accessories, "trouble-shooting" maintenance guide, and spare parts lists. Include this data, product data, and shop drawings in maintenance manuals; in accordance with requirements of Division 1.

1.3 DELIVERY, STORAGE, AND HANDLING

Handle terminal units and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged terminal units or components; replace with new.

Store terminal units and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.

Comply with Manufacturer's rigging and installation instructions for unloading terminal units, and moving them to final location.

PART 2 - PRODUCTS

2.0 MANUFACTURERS

Manufacturer: Subject to compliance with requirements, provide products by one of the following:

Baseboard Radiation:

Modine Mfg. Co.
Slant/Fin Corp.
Standard Fin-Pipe Radiator Corp.
Sterling Radiator; Division of Reed National Corp.

Trane (The) Co.
Vulcan Radiator Corp.
Zehnder Rittling
Sigma Products

Unit Heaters:

Airtherm Mfg. Co.
Daikin
Modine Mfg. Co.
Trane (The) Co.
Wing (The) Co.; Division Wing Industries, Inc.
Young Radiator Co.
Vulcan Radiator Corp.
Zehnder Rittling
Sigma Products

Cabinet Unit Heaters:

Airtherm Mfg. Co.
Daikin.
Modine Mfg. Co.
Trane (The) Co.
Young Radiator Co.
Vulcan Radiator Corp.
Zehnder Rittling
Sigma Products

2.1 BASEBOARD RADIATION

General: Provide hot water baseboard radiation of lengths, wall-to-wall enclosure, in locations as indicated, of capacities, style, and having accessories as scheduled.

Cabinets: Minimum 20 gauge cold-rolled steel, 1-piece back and top panel, front panel with integral damper. Provide steel brackets inserted in back/top panel, to support element and front panel. Provide standard baked enamel finish on topside and front panel only.

Submit color chart for selection by Architect.

Elements: Copper tube and aluminum fins, with slide mechanism between element and support brackets to eliminate expansion and contraction noises.

Accessories: Provide the following accessories:

End panels, inside and outside corners, and enclosure extensions.
Removable 18-inch long cover access section in front of valves, balancing cocks, and traps.
Factory-mounted dampers.
Sill extensions.
Mullion channels.
Pilaster covers.
Pipe Slide Guides glide on support brackets to eliminate expansion and contraction noises.

2.2 UNIT HEATERS

General: Provide unit heaters in locations as indicated, and of capacities, style, and having accessories as scheduled.

Horizontal Unit Heaters:

Casings: Construct of steel, phosphatized inside and out, and finished with standard color baked enamel finish. Provide motor-mounted panel, minimum of 18 gauge steel. Fabricate casing to enclose coil, louvers, and fan blades. Provide louvers for 4-way air diffusion.
Fans: Construct of aluminum, and factory-balance. Provide fan inlet orifice, smooth, and drawn into casing back panel.

Coils: Construct of plate-type aluminum fins, mechanically bonded to copper tubes. Design coil for use in hot water applications.

Motors: Provide totally enclosed motors, with built-in overload protection, having electrical characteristics as scheduled.

2.3 CABINET UNIT HEATERS

General: Provide hot water cabinet heaters having cabinet sizes and in locations as indicated, and of capacities, style, and having accessories as scheduled. Include in basic unit chassis, coil, fanboard, fan wheels, housings, motor, and insulation.

Chassis: Galvanized steel wrap-around structural frame with edges flanged.

Insulation: Faced, heavy density glass fiber.

Cabinet: 16 Gauge removable front panel, 18 gauge top and side panels. Insulate front panel over entire coil section. Provide access door on coil connection side. Clean cabinet parts, bonderize, phosphatize, and flow-coat with standard factory color selected baked enamel finish, color as selected by Architect.

Water Coils: Construct of 5/8-inch seamless copper tubes mechanically bonded to configurated aluminum fins. Design for 300 psi and leak test at 300 psi under water. Provide same end connections for supply and return.

Fans: Provide centrifugal, forward curved double width fan wheels constructed of non-corrosive, molded, fiberglass-reinforced thermoplastic material. Construct fan scrolls of galvanized steel.

Motors: Provide shaded pole motors with integral thermal overload protection, and motor cords for plug-in to junction box in unit.

Filters: Provide replaceable "sock" type filters. Provide tack-welded wire frame custom made for CUH to replace factory filters.

Accessories: Provide the following accessories as indicated and/or scheduled:

Wall Boxes: Provide aluminum wall boxes with integral eliminators and insect screen.
Recessing Flanges: Provide 18 gauge steel flanges for recessing cabinet heaters into wall or ceiling.
Sub-bases: Provide 18 gauge steel sub-base for vertical units, height as indicated.
Extended Oilers: Provide plastic motor oiler tubes extending to beneath top discharge grille.

PART 3 - EXECUTION

3.0 INSPECTION

Examine areas and conditions under which terminal units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.1 INSTALLATION OF BASEBOARD RADIATION

General: Install baseboard radiation as indicated, and in accordance with manufacturer's installation instructions.

Locate baseboard radiation on outside walls as indicated, run cover continuous wall-to-wall unless otherwise indicated.

Center elements under windows. Where multiple windows occur over units, divide element into equal segments centered under each window.

Install end caps where units butt against walls. Install access panels centered in front of each shutoff valve, balancing cock, or temperature control valve.

3.2 INSTALLATION OF UNIT HEATERS

General: Install unit heaters as indicated, and in accordance with manufacturer's installation instructions.

Uncrate units and inspect for damage. Verify that nameplate data corresponds with unit designation.

Hang units from building substrate, not from piping. Mount as high as possible to maintain greatest headroom possible unless otherwise indicated.

Support units with rod-type hangers anchored to building substrate.

Install piping as indicated.

Protect units with protective covers during balance of construction.

3.3 INSTALLATION OF CABINET HEATERS

General: Install cabinet heaters as indicated, and in accordance with manufacturer's installation instructions.

Locate cabinet heaters as indicated, coordinate with other trades to assure correct recess size for recessed units.

Install piping as indicated.

Protect units with protective covers during balance of construction.

3.4 ELECTRICAL WIRING

General: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.

Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment Installer.

3.5 ADJUSTING AND CLEANING

General: After construction is completed, including painting, clean unit exposed surfaces, vacuum clean terminal coils and inside of cabinets.

Retouch any marred or scratched surfaces of factory-finished cabinets, using finish materials furnished by manufacturer.

Install new filter units for terminals requiring same.

3.6 START-UP

Start-up, test, and adjust terminal units in accordance with manufacturer's published start-up instructions. Adjust for proper air flow where applicable.

END OF SECTION 23 82 00

SECTION 23 83 17

RADIANT-HEATING SNOWMELT PIPING

PART 1 - GENERAL

1.0 RELATED DOCUMENTS

Drawings and general provisions or the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.1 SUMMARY

Snow and ice melting systems (SIM), where shown on the Drawings and Schedules, shall be hydronic.

The work in this Section includes, but is not limited to the following:

- Crosslinked polyethylene (PEXa) piping.
- Distribution manifold(s) with balancing and flow control valves where required.
- Pipe-to-manifold compression nut fittings.
- Cold-expansion and compression-sleeve fittings.
- Pipe fasteners as approved by the manufacturer of the piping.
- Systems Controls and Automation.
- Manufacturer supported supervision and field engineering required for the complete and proper function of the system.

1.2 SUBMITTALS

General: Submit listed submittals in accordance with Conditions of the Contract and Division 1 Submittal Procedures Section.

Product Data: Submit manufacturer’s product submittal data and installation instructions.

Submit the following shop drawings, calculations and reports.

- Submit shop drawings for piping installation in the project. Indicate all valves, pumps and items of equipment that are required to control and operate the hydronic radiant system for heating as shown on the drawings and described in the sequence of operations. Submit a valve and pump schedule listing each number, type, size, model and service. Cross reference to supporting product data.
- Submit manufacturer's detailed drawings showing layouts, fixing details and piping details of all areas where hydronic radiant systems are indicated along with product and performance data for each component.
- Provide calculations that support the heating performance requirements of the hydronic radiant system. These calculations should show the flow through the system for heating as well as the primary heating connections to the radiant system headers and control circuits. Provide system pressure-drop calculations as well.
- Submit drawings showing details of manifolds, including all connections and valves. If manifolds are to be installed on a wall, then the details should include all fixture details. If the manifolds are to be installed in wall cavities, then provide all fixture and access details.
- Specify piping materials and temperature/pressure ratings.
- Provide drawings showing the location of all expansion and penetration sleeves, showing coordination with concrete slab expansion joints. Provide confirmation of concrete slab expansion requirements and the use of any concrete additives.
- Provide drawings showing piping manifold locations and installation details.

Provide control sequences and requirements for control hardware devices. Indicate compliance and coordination with requirements of other specification sections.
Provide piping sample with certification of properties.
Submit manufacturer's report detailing that the hydronic radiant system has been installed in accordance with this specification and the manufacturer's specified instructions.
Submit report indicating that installation was performed according to the manufacturer's instructions. Include pressure testing documentation as required in related specification sections.
Submit start-up report demonstrating that system meets required capacity, is fully functional and commissioned to the satisfaction of system manufacturer.
Provide installation drawings indicating tubing layout, manifold locations, zoning requirements and manifold schedules with details required for installation of the system.
Provide sectional drawing of floor slab demonstrating coordination with other construction trades and showing insulation, if required.

Quality Assurance/Control Submittals: Submit test reports. Upon request, submit test reports from recognized testing laboratories.

Documentation: Submit the following documentation:

Manufacturer’s certificate indicating products comply with specified requirements.

Submit independent certification results for the piping systems from an accredited independent testing laboratory.
The design shall be approved by a professional appropriately licensed in the jurisdiction where the installation will take place, as being complete and accurate.
Fittings shall be third-party certified to applicable referenced standards as part of the manufacturer’s PEX piping system, with independent listings from NSF, CSA and ICC, as applicable.
Fittings embedded within the thermal mass or encased behind walls or ceilings shall be certified to ASTM F2080.

Manufacturer’s detailed zone-by-zone heat-loss analysis for the structure.
Documentation indicating the installer is trained to install the manufacturer’s products.

Close-out Submittals: Submit the following documents.

Warranty documents specified herein
Operation and maintenance data
Manufacturer’s field reports specified herein
Final as-built tubing layout drawing

Submit computer-generated SIM system design indicating heat flux, pipe sizing, spacing, flow rates, and temperatures. SIM design calculations shall be performed on pipe manufacturer’s software.

1.3 QUALITY ASSURANCE

References

General: Standards listed by reference, including revisions by issuing authority, form a part of this specification section to the extent indicated. Standards listed are identified by issuing authority, authority abbreviation, designation number, title or other designation established by issuing authority. Standards subsequently referenced herein are cited by issuing authority abbreviation and standard designation.

ASTM – American Society for Testing and Materials

ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials.
ASTM E119 Standard Test Methods for Fire Tests of Building Construction and Materials
ASTM F876 – Standard Specification for Crosslinked Polyethylene (PEX) Tubing.
ASTM E814 Standard Test Method for Fire Tests of Through-Penetration Fire Stops
ASTM F877 – Standard Specification for Crosslinked Polyethylene (PEX) Plastic Hot- and Cold-Water Distribution Systems.
ASTM F2014 – Standard Specification for Non-Reinforced Extruded Tee Connections for Piping Applications.
ASTM F2080 – Standard Specification for Cold-Expansion Fittings With Metal Compression-Sleeves for Cross-Linked Polyethylene (PEX) Pipe.

CSA – Canadian Standards Association

CSA B137.5 – Crosslinked Polyethylene (PEX) Tubing Systems for Pressure Applications.
CSA B214 – Installation Code for Hydronic Heating Systems.

American National Standards Institute (ANSI)/Underwriters Laboratories, Inc. (UL)

ANSI/UL 263 Standard for Safety for Fire Tests of Building Construction and Materials

IAPMO – International Association of Plumbing and Mechanical Officials

Uniform Mechanical Code

ICC – International Code Council

International Mechanical Code (IMC)
ICC Evaluation Service (ES) Evaluation Report No ESR-1099

ISO – International Organization for Standardization

ISO 9001 – Quality Management Systems – Requirements

ULC – Underwriters' Laboratories of Canada

CAN/ULC S102.2 – Surface Burning Characteristics of Flooring, Floor Covering and Miscellaneous Materials.

PPI – Plastic Pipe Institute

TR-3 / 2007 – Policies and Procedures for Developing Hydrostatic Design Basis (HDB), for thermoplastic piping materials or pipe.
TR-4/2007- Recommended Hydrostatic Pressure Design Basis (PDB), Strength Design Basis (SDB), and Minimum Required Strength (MRS) Ratings for Thermoplastic Piping Materials or Pipe.

1.4 DEFINITIONS

Crosslinked polyethylene, commonly abbreviated PEX, is made from high density polyethylene (HDPE). Crosslinking is accomplished during manufacturing. Crosslinking enhances the physical & mechanical properties of the polymer. The high-temperature properties are improved. Chemical resistance is enhanced by resisting dissolution. Low temperature properties are also improved; its impact and tensile strength, scratch resistance, and resistance to brittle fracture are enhanced. The required degree of crosslinking, according to ASTM Standard F876-07, is between 70 - 89%. This specification requires PEX to be designated as PEXa and be manufactured by the high-pressure peroxide method.

1.5 DELIVERY, STORAGE, AND HANDLING

Comply with Division 1, Product Requirements.

Deliver and store piping and equipment in shipping containers with labeling in place.

Pipe shall be kept in original shipping boxes until required for installation.

Store piping and equipment in a safe place, dry, enclosed, under cover, in a well-ventilated area.

Do not expose pipe to ultraviolet light beyond exposure limits recommended by manufacturer.
Protect piping and manifolds from entry of contaminating materials. Install suitable plugs in open pipe ends until installation.
Where possible, connect pipes to assembled manifolds to eliminate possibility of contaminants and cross-connections.
Piping shall not be dragged across the ground or other surfaces, and shall be stored on a flat surface with no sharp edges.

Protect materials from damage by other trades.

Pipe shall be protected from oil, grease, paint, direct sunlight and other elements as recommended by manufacturer.

1.6 WARRANTY

Project Warranty: Refer to Conditions of the Contract for project warranty provisions.

Manufacturer’s Warranty: Submit, for Owner’s acceptance, manufacturer’s standard warranty document executed by authorized company official. Manufacturer’s warranty is in addition to, and not a limitation of, other rights Owner may have under contract documents.

Warranty shall transfer to subsequent owners.
Warranty Period for PEX Tubing: 30-year, non-prorated warranty against failure due to defect in material or workmanship, beginning with date of substantial completion when installed by a factory-trained contractor
Warranty Period for Manifolds and Fittings: 5-year, non-prorated warranty against failure due to defect in material or workmanship, beginning with date of substantial completion when installed by a factory-trained contractor
Warranty Period for Controls and Electrical Components: 2-year, non-prorated warranty against failure due to defect in material or workmanship, beginning with date of substantial completion when installed by a factory-trained contractor

If a factory-trained contractor does not install the system, then the most recent limited warranty published by the PEX tubing manufacturer takes precedence.

PART 2 - PRODUCTS

2.0 HYDRONIC RADIANT HEATING AND/OR COOLING SYSTEM

Manufacturer:

Uponor, Inc.(Wirsbo)
Rehau
Mr. Pex

2.1 PRODUCT SUBSTITUTIONS

All products, components, etc., specified herein are manufactured by and/or available from the PEX tubing manufacturer.

2.2 PIPING

Snow and ice melt system pipe shall be high-density crosslinked polyethylene manufactured using the high-pressure peroxide method of crosslinking (PEXa). Pipe shall conform to ASTM F876, ASTM F877 and CSA B137.5.

Pipe shall be rated for continuous operation of 100 psi gauge pressure at 180°F temperature (690 kPa @ 82°C), and 80 psi gauge pressure at 200°F temperature (550 kPa @ 93°C).

When required, pipe shall have a co-extruded oxygen diffusion barrier capable of limiting oxygen diffusion through the pipe to less than 0.10 mg/l/day at 104°F (40°C) water temperature, in accordance with DIN 4726.

Bend Radius:

The minimum bend radius for cold bending of the pipe shall be not less than five (5) times the outside diameter.
Bends with a radius less than this shall require the use of a bending template as supplied by the pipe manufacturer, and/or hot air.

Pipe to have a Flame Spread Index of less than 25, and a Smoke Developed Index of less than 50 when tested in accordance with ASTM E84 (in U.S.) or CAN/ULC S102.2 (in Canada). In any case where the pipe does not conform to these standards, appropriate piping insulation shall be installed in order to meet the standard.

2.3 FITTINGS

Fittings shall be third-party certified to applicable standards ASTM F877, ASTM F2080 and CSA B137.5 as part of the manufacturer's PEX piping system, with independent listings from NSF, CSA and ICC, as applicable.

Compression nut manifold fittings shall be manufactured of brass with a barbed insert and a reusable split compression ring.

Compression-sleeve fittings shall be manufactured of brass and shall be supplied by the piping manufacturer as part of a proven cataloged system.

Fittings embedded within the thermal mass or encased behind walls or ceilings shall be cold-expansion compression-sleeve fittings certified to ASTM F2080. Where required by the manufacturer, fittings shall be protected from external environmental conditions.

2.4 MANIFOLDS

Material: Distribution manifolds shall be manufactured of brass or copper and be supplied by the piping manufacturer as a proven cataloged part of the manufacturer's system.

Brass manifolds shall be produced from extruded brass round pipe with tapped holes for connections, and be pre-assembled by the manufacturer. 100% of manifolds used shall have been air tested by the manufacturer with no indication of leaks.

Balancing Manifolds:

Where required by design, brass balancing manifolds shall be equipped with integral visual flow gauges, circuit balancing and flow control valves, isolation valves with integral thermometer housings, and air vent/fill ports.
Each circuit valve shall be supplied with a manual actuating handle for filling/purging operation.

Copper manifolds

Copper manifolds shall be manufactured from Type L copper.
Copper and/or brass outlets shall be high-temperature brazed (lead-free) into headers.
Outlets in copper headers shall be made using the T-drill process according to ASTM F2014.

2.5 CONTROLS

Automatic SIM Detector and Melting Controls

SIM control shall use low-voltage devices to monitor outdoor ambient, slab, fluid supply and/or return temperatures, as well as an automatic snow and ice detector to detect moisture in the SIM zone.
SIM control shall be capable of maintaining a set temperature in a SIM slab or thermal mass, with adjustable settings for Idle and Melting mode.
Connection to output devices shall be as per the recommended installation of the SIM control, as part of a proven cataloged system.

PART 3 - EXECUTION

3.0 ACCEPTABLE INSTALLERS

As a minimum, installation shall be performed by qualified laborers trained by the manufacturer in the procedures of PEX SIM systems and they shall be appropriately licensed for the jurisdiction where the installation will take place for a period of three years.

3.1 EXAMINATION

Examine areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of Work.

Do not proceed until unsatisfactory conditions are corrected.

Beginning of installation means acceptance of existing conditions.

3.2 PREPARATION

Coordinate with related trades and manufacturer's recommendations with regard to installation in conjunction with:

Reinforcing wire mesh or rebar.
Precast or existing concrete sub-grade.
Asphalt or other hot mix.
Patio pavers.
Preparation of space for manifold installation.
Mounting outdoors or in an unheated indoor environment.

3.3 INSTALLATION

Install in accordance with manufacturer's published installation manual and/or published guidelines and final shop drawings.

Mount manifolds in the locations previously prepared or in previously installed cabinets, if used. Manifolds shall be mounted as level as possible.

Route piping in an orderly manner, according to layout and spacing shown in final shop drawings.

At connections and fittings, use a plastic pipe cutter to ensure square and clean cuts, and join pipes immediately or cap ends of pipe to seal from contaminants. Where fittings are installed within the thermal mass, they shall be wrapped in chloride-free tape or sealed within a heat-shrink material approved by the manufacturer.

Pipe shall be dispensed using a suitable uncoiling device. Remove twists prior to securing pipe. Pipe shall lie flat on an even plane. Finished grade of a thermal mass shall be a minimum of 3/4 inch (19 mm) above the top of PEX heating pipes. Fasten piping at no more than 3 feet (90 cm) intervals, being careful not to twist the pipe. In thin concrete slabs, secure piping every 2 feet (60 cm). Use only fasteners supplied or approved by the manufacturer of the PEX pipe.

Piping that shall pass through expansion joints shall be covered in protective polyethylene convoluted sleeving (flexible conduit) extending 15 inches (38 cm) on each side of the joint. Sleeving shall be secured on pipe to prevent movement during installation of thermal mass.

Where piping exits the thermal mass, a protective conduit shall be placed around the pipe, with the conduit extending a minimum of 6 inches (15 cm) into the floor and exiting by a minimum of 6 inches (15 cm). For penetrations at manifolds, use rigid PVC bend guides secured in place to prevent movement.

At the time of installation of each circuit of pipe, connect the pipe to the correct manifold outlet and record pipe length for balancing. If manifold is not installed, cap the end of the pipe and label the pipe's circuit numbers along with S for supply and R for return. Connect pipes to manifold as soon as possible and record circuit lengths. Circuits shall be labeled to indicate circuit length and serviced area.

If the SIM system substrate material (thermal mass) requires curing and/or has other limitations which can be influenced by the SIM system while in operation, then the SIM system shall not be put into operation until such time that the substrate material has fully cured or set according to the material requirements of the substrate manufacturer.

The installer shall confirm minimum and maximum exposure temperatures for the substrate material (thermal mass) and shall ensure proper SIM operating temperatures.

3.4 FIELD QUALITY CONTROL

Filling, Testing & Balancing: Tests of hydronic heating systems shall comply with authorities having jurisdiction, and, where required, shall be witnessed by the building official.

Pressure gauges used shall show pressure increments of 1 psig and shall be located at or near the lowest points in the distribution system.

Air Test

Charge the completed, yet unconcealed pipes with air at a minimum of 40 psig.
Do not exceed 150 psig.
Use liquid gas detector or soap solution to check for leakage at manifold connections.

Water Test

Purge air from pipes.
Charge the completed, yet unconcealed pipes with water.
Take necessary precautions to prevent water from freezing.
Check the system for leakage, especially at pipe joints.

Perform a preliminary pressure test pressurizing the system to the greater of 1.5 times the maximum operating pressure or 100 psig for 30 minutes.

As the piping expands, restore pressure, first at 10 minutes into the test and again at 20 minutes.
At the end of the 30-minute preliminary test, pressure shall not fall by more than 8 psig from the maximum, and there shall be no leakage.

After successfully performing the preliminary test, perform the main pressure test immediately.

The main pressure test shall last 2 hours.
The test pressure shall be restored and shall not fall more than 3 psig after 2 hours.
No leakage shall be detected.

Pressure shall be maintained and monitored during installation of the thermal mass.

If any leak is detected during installation of thermal mass, leak shall be found immediately and the area cleared for repair using manufacturer's approved repair coupling.
Retest before covering repair.

Complete inspection and furnish test reports supplied by the manufacturer of the system.

3.5 CLEANING

Clean exposed surfaces upon completion of installation using clean, damp cloth. No cleaning agents are allowed.

Comply with manufacturer's recommendations.

Compare or replace damaged installed products.

Remove construction debris from project site and legally dispose of debris.

3.6 PROTECTION

Protect installation throughout construction process until date of final completion.

Replace components that cannot be repaired.

3.7 DEMONSTRATION

Demonstrate operation of hydronic radiant heating and/or cooling system to Owner's personnel.

Advise the Owner's Representative about the type and concentration of glycol and water solution if used in the hydronic radiant heating and/or cooling system.

The Owner monitors the solution effectiveness through an established maintenance program as outlined by the glycol manufacturer.

END OF SECTION 23 83 16

SECTION 26 05 00

BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.0 RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.1 SUMMARY

Description: Work shall consist of furnishing all labor, equipment, supplies, and materials, unless otherwise specified, necessary for the installation of complete electrical systems as required by the specifications and as shown on the drawings, subject to the terms and conditions of the contract. The Work shall also include the completion of those details of electrical work not mentioned or shown which are necessary for the successful operation of all electrical systems.

Certain labor, materials, and equipment may be furnished under other Sections of these specifications, by Utility Companies or by the Owner. When this is the case, the extent, source and description of these items will be as indicated on the drawings or as described in the specifications.

1.2 RELATED SECTIONS

Basic Electrical Requirements specifically applicable to Division 26 Sections, in addition to Division 1 - General Requirements.

1.3 REFERENCE STANDARDS & REGULATORY REQUIREMENTS

Comply with the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents. A listing of applicable reference standards is contained in Division 1.

Latest editions of the following:

ANSI/NFPA 70 - National Electrical Code (as adopted and amended by the Billings Building Department).
International Codes (as adopted and amended by the Billings Building Department)
ANSI/IEEE C2 - National Electrical Safety Code.
NECA - Standard of Installation.
Other references as listed elsewhere in these specifications.

Obtain electrical permits, plan review, and inspections from authority having jurisdiction in accordance with Division 1.

The drawings and specifications take precedence when they are more stringent than codes, statutes, or ordinances in effect. Applicable codes, ordinances, standards and statutes take precedence when they are more stringent than, or conflict with the drawings and specifications.

1.4 DEFINITIONS

"Furnish" or "Provide": To supply, install and connect up complete and ready for safe and regular operation of particular work unless specifically otherwise noted.

"Install": To erect, mount and connect complete with related accessories.

"Supply": To purchase, procure, acquire and deliver complete with related accessories.

"Work": Labor, materials, equipment, apparatus, controls, accessories, and other items required for proper and complete installation.

"Wiring": Raceway, fittings, wire, boxes and related items.

"Concealed": Embedded in masonry, concrete or other construction, installed in furred spaces, within double partitions or hung ceilings, in trenches, in crawl spaces, or in enclosures.

"Exposed": Not installed underground or "concealed" as defined above.

"Indicated," "Shown" or "Noted": As indicated, shown or noted on drawings or specifications.

"Similar" or "Equal": Equal in materials, weight, size, design, construction, capacity, performance, and efficiency of specified product.

"Reviewed," "Satisfactory," "Accepted," or "Directed": As reviewed, satisfactory, accepted, or directed by or to Engineer.

"Related Work" includes, but is not necessarily limited to, mentioned work associated with, or affected by, the work specified.

Refer to Article 100 of the currently adopted National Electrical Code for other definitions as applicable to this project.

1.5 WORK SEQUENCE

Construct Work in sequence under provisions of Division 1 where applicable.

1.6 DRAWINGS AND SPECIFICATIONS

The drawings indicate the general arrangement of circuits and outlets, locations of switches, panelboards and other work. Information shown on the drawings is schematic, however, recircuiting will not be permitted without specific acceptance. Drawings and specifications are complementary each to the other. What is called for by one shall be as binding as if called for by both. Data presented on these drawings is as accurate as planning can determine, but accuracy is not guaranteed and field verification of all dimensions, locations, levels, etc., to suit field conditions is directed. Review all Architectural, Structural, Mechanical, Plumbing, Technology and Audio/Visual Drawings and Specifications; adjust all work to conform to all conditions shown therein. The Architectural drawings shall take precedence over all other drawings.

Discrepancies between different plans, between plans and specifications, between specifications, or regulations and codes governing this installation shall be brought to the attention of the Engineer in writing before the date of bid opening. In the event such discrepancies exist, and the Engineer is not so notified, the adjudication of responsibility shall be solely at the discretion of the Engineer.

1.7 COORDINATION

Prior to fabrication or installation of any electrical work, participate in detailed coordination planning meetings with all other building utilities system trades, under the direction of the General Contractor, so as to completely establish routings, elevations, space requirements, and coordination of access, layout, and suspension requirements in relationship to the building structure and the work of all other trades.

1.8 SUBMITTALS (Refer to Division 1)

Submit shop drawings and product data in accordance with provisions of Division 1.

Prior to submission, shop drawings, material lists and catalog cuts or manufacturer's printed data shall be thoroughly checked for compliance with contract requirements, compatibility with equipment being furnished by the Contractor or Owner, accuracy of dimensions, coordination with work of other trades, and conformance with sound and safe practice as to erection of installation. Each submittal shall bear Contractor's signed statement evidencing such checking.

The contractor is to prepare a submittal schedule that coincides with the overall construction schedule and submit prior to the first submittal submission. This submittal schedule should include a list of individual products to be submitted under each specification section. This submittal schedule shall also include dates for anticipated review, shipment and on-site delivery times of the submitted product.

The Engineer shall be given a submittal review time of ten (10) working days upon receipt of submittal. Previous submittal rejection or revision shall not compress this review time. It shall be the contractor’s responsibility to ensure these review and/or re-review times are incorporated into the submittal schedule with enough lead time as not to affect overall construction schedule.

Submit all submittal items required per each electrical specification section. Submittals shall be prepared and submitted in accordance with the submittal schedule. The contractor is to determine and coordinate submittal review times, lead times and delivery times of submitted products as it coincides with the overall construction schedule. Submittals submitted in bulk or under a single division will not be review and will be sent back as “revise and resubmit”.

Clearly mark each shop drawing as follows for purposes of identification:

Shop Drawing
Equipment Identification Used on Contract Drawings
Date
Name of Project
Branch of Work
Engineer's Name
Contractor's Name

Clearly mark printed material, catalog cuts, pamphlets or specification sheets, and shop drawings with the same designation shown on the contract document schedules. Identify specific item proposed, showing catalog number, recess openings, dimensions, capacities, electrical characteristics, etc. Submittals which are incomplete will be returned to the Contractor without review.

Submittals to be provided with “Bookmarks” for engineer review. Submittals without bookmarks are subject to being returned without review and for re-submission.

Contractor agrees that submittals processed by the Engineer are not change orders; that the purpose of submittals is to demonstrate to the Engineer that the Contractor understands the design concept; and that the Contractor demonstrates this understanding by indicating which equipment and material he intends to furnish and install and by detailing the fabrication and installation methods he intends to use.

Contractor shall be responsible for dimensions (which he shall confirm and correlate at the job site), fabrication processes and techniques of construction, and coordination of his work with that of other trades. The Contractor shall check and verify all measurements and review shop drawings before submitting them. If any deviations from the specified requirements for any item of material or equipment exist, such deviation shall be expressly stated in writing and incorporated with the submittal.

Maintain one copy of shop drawings at the project field office until completion of the project, and make this copy available, upon request, to representatives of the Engineer and Owner.

No equipment or materials shall be installed or stored at the jobsite until submittals for such equipment or materials have been given review action permitting their use.

Shop drawings and manufacturer's published data shall be submitted for the following pieces of equipment at a minimum. Submit other electrical equipment identified to be submitted in each specification section.

Switchboards
Panelboards
Transformers
Luminaires (catalog cuts)
Automatic transfer switches
Packaged Generator Set

1.9 REQUESTS FOR INFORMATION

All “Requests for Information” submitted by the Contractor shall include a proposed solution and an estimated cost/schedule impact. Any RFI’s that do not contain this required information will be sent back to the Contractor unanswered.

Schedule the work to provide the Engineer a minimum review time of five (5) business days upon receipt of RFIs to provide a response.

1.10 RECORD DOCUMENTS

Maintain a contract set of electrical drawings at the site. Neatly mark all changes, discoveries and deviations from the original drawings. Use a color which contrasts with the prints. This shall be a separate set of drawings, not used for construction purposes, and shall be kept up to date as the job progresses and shall be made available for inspection by the Engineer at all times. Upon completion of the contract, this set of record drawings shall be delivered to the Engineer. Record documents to be provided by the Contractor shall clearly and accurately show the following:

Major raceway systems, size and location, for both exterior and interior; locations of control devices; distribution and branch electrical circuitry; and fuse and circuit breaker size and arrangements.
Equipment locations (exposed and concealed) Including but not limited to Switchboards, panelboards and transformers shall be physically dimensioned and also dimensioned from prominent building lines.
Approved substitutions, Contract Modifications, and actual equipment and materials installed.

PART 2 - PRODUCTS

2.0 MATERIALS AND EQUIPMENT

Materials and Equipment: Acceptable to the authority having jurisdiction as suitable for the use intended, except where more stringent requirements are indicated by the Contract Documents.

Compatibility with Available Space: Equipment layouts shown are based on use of equipment as specified. If the Contractor chooses equipment available from any other manufacturer listed as an acceptable manufacturer, or offers equipment under the provision for substitutions, the Contractor shall be solely responsible for first ascertaining that the offered equipment can be installed in the space available with ample clearances for maintenance. Include coordination drawings, as specified herein, when required.

All equipment and materials installed shall be new, unless otherwise specified.

Defective or damaged materials shall be replaced or repaired, prior to final acceptance, in a manner acceptable to the Engineer or Owner and at no additional cost to the Owner.

All electrical materials shall be acceptable for installation only if labeled or listed by a nationally recognized testing laboratory and if accepted by local authorities and shall bear an attached UL label.

All major equipment components shall have the manufacturer's name, address, model number, and serial number permanently attached in a conspicuous location.

2.1 STORAGE AND PROTECTION

Store products in accordance with manufacturer's instructions, with seals and labels intact and legible. Store sensitive products in weather-tight enclosures; maintain within temperature and humidity ranges required by manufacturer's instructions.

For exterior storage of fabricated products, place on sloped supports above ground. Cover products subject to deterioration with impervious sheet covering; provide ventilation to avoid condensation.

Arrange storage to provide access for inspection. Periodically inspect to assure products are undamaged and are maintained under required conditions.

2.2 PRODUCT OPTIONS

Products Specified by Reference Standards or by Description Only: Any product meeting those standards.

Products Specified by Naming One or More Manufacturers with a Provision for Substitutions: Submit a request for substitution for any manufacturer not specifically named.

Products Specified by Naming One or More Manufacturers without a Provision for Substitutions: Products of named manufacturers meeting specifications; no options, no substitutions allowed.

2.3 PRODUCTS LIST

Within 30 days after date of Owner-Contractor Agreement, submit complete list of major products required for submittal under these specifications, with name of manufacturer, trade name, and model number of each product.

2.4 SUBSTITUTIONS

Refer to Division 1.

2.5 GUARANTEE

The entire electrical system installed under this Contract shall be left in proper working order. Replace, at no additional cost to the Owner, any work, materials, or equipment which evidences defects in design, construction, or workmanship within two years, or as specifically noted elsewhere in these specifications, from date of final acceptance.

PART 3 - EXECUTION

3.0 WORKMANSHIP

Install work using procedures defined in NECA Standard of Installation.

Workmanship shall conform to highest industry standards for each trade involved in erection of the work and installed in a “Neat and Workmanlike manner” per the NEC.

Contractor's personnel and subcontractors selected to perform the work shall be well versed and skilled in the trades involved.

Any changes or deviations from the drawings and specifications must be accepted in writing by the Engineer. All errors in installation shall be corrected at the expense of the Contractor. All specialties shall be installed as detailed on the drawings. Where details or specific installation requirements are not provided, manufacturer's recommendations shall be followed.

Upon completion of work, all equipment and materials shall be installed complete, thoroughly checked, correctly adjusted, and left ready for intended use or operation. All work shall be thoroughly cleaned and all residue shall be removed from surfaces. Exterior surfaces of all material and equipment shall be delivered in a perfect, unblemished condition.

Contractor shall provide a complete installation, including all required labor, material, cartage, insurance, permits, and taxes.

3.1 CHASES, OPENINGS, CUTTING AND PATCHING

Carefully lay out all work in advance so as to eliminate where possible, cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings and roofs. Any damage to the building, structure, piping, ducts, equipment or any defaced finish shall be repaired by skilled mechanics of the trades involved at no additional cost to the Owner and to the satisfaction of the Architect/Engineer. Any necessary cutting, channeling, drilling or welding as required for the proper support, concealment, installation or anchoring of raceways, outlets, or other electrical equipment shall be performed in a careful manner, and as approved by the Engineer.

All openings made in fire-rated walls, floors, or ceilings shall be patched and made tight in a manner to conform to the fire rating for the surface penetrated.

All penetrations required through completed concrete construction shall be core drilled at minimum size required. Precautions shall be taken when drilling to prevent damage to structural concrete. The Contractor shall obtain permission from the Engineer before proceeding with drilling.

3.2 ELECTRICAL INSTALLATIONS

Coordinate electrical systems, equipment, and materials installation with other building components and trades. If equipment of a different size is furnished by the Contractor, the Contractor shall furnish and install the proper motor starter, fuses, circuit breaker, disconnect switch, wire and conduit required for the equipment furnished, at no additional cost to the Owner and shall be approved by the Owner.

3.3 PROGRESS OF WORK

Order the progress of electrical work to conform to the progress of the work of the other trades. Complete the entire installation as soon as the condition of the building will permit. Any cost resulting from defective or ill-timed work performed under this Section shall be borne by this Contractor.

3.4 TRENCHING AND BACKFILLING

Perform all trenching and backfilling required by work performed under this Section in accordance with the excavating and grading specifications and as herein specified. Refer to Specification Section 260533 for Underground Conduit and Ductbank identification requirements.

Excavate trenches to the depth required for the utilities involved. The trench bottom shall be graded true and free from stones or soft spots, bottom of trenches must be compacted.

After installation of electrical work, backfill, tamp, and compact to insure against the possibility of differential settling, in conformity with Division 2 Specifications. Verify location of existing or new utilities and, if damaged by this Contractor, replace or repair.

3.5 ELECTRICAL COMPLETION

Indoctrination of Operating and Maintenance Personnel: Furnish the services of a qualified representative of the supplier of each item or system itemized below who shall instruct specific personnel, as designated by the Owner, in the operation and maintenance of that item or system.

Instruction shall be given when the particular system is complete and shall be of the number of hours indicated and at the time requested by the Owner. A representative of the Contractor shall be present for all demonstrations.

System	Hours Of Instruction	
Electrical Distribution Equipment (under 600 volts)	24	(4 6-hour sessions)
Emergency System	8	(2 4- hour sessions)
Packaged Generator Set	16	(4 4-hour sessions)

Operating and Maintenance Manuals and Parts Lists: Deliver three (3) complete operating & maintenance manuals and parts lists to the Owner at the time of the above required indoctrination. Fully explain the contents of the manuals as part of required indoctrination and instruct the Owner's personnel in the correct procedure in obtaining service, both during and after the guarantee period.

The operating and maintenance manuals and parts lists shall give complete information as to whom the Owner shall contact for service and parts. Include address and phone number. Furnish evidence that an authorized service organization regularly carries a complete stock of repair parts for these items (or systems), and that the organization is available for service. Service shall be furnished within 24 hours after requested.

Operating and Acceptance Tests: Provide all labor, instruments, and equipment for the performance of tests as specified below and elsewhere in these specifications. Submit three copies of a typewritten test report to the Engineer for his approval.

For a seven-day period after building has been placed into normal service, record the full load current in each phase or line at the main service entrance and submit to the Engineer.

Perform a careful inspection of the main switchboard bus structure and cable connections to verify that all connections are torqued to manufacturer's recommendations.

Clean-Up: Remove all materials, scrap, etc., relative to the electrical installation, and leave the premises and all equipment, lamps, luminaires, etc. in a clean, orderly condition. Any costs to the Owner for clean-up of the site will be charged against the Contractor.

Acceptance Demonstration: Upon completion of the work, at a time to be designated by the Engineer, the Contractor shall demonstrate for the Owner the operation of the entire installation, including all systems provided under this contract.

Final acceptance by the Owner will not occur until all operating instructions are received and Owner's personnel have been thoroughly indoctrinated in the maintenance and operation of all equipment.

END OF SECTION 26 05 00

SECTION 26 05 19

BUILDING WIRE AND CABLE

PART 1 - GENERAL

1.0 RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.1 SUMMARY

Building Wire and Cable.

Metal Clad Cable.

Wiring Connections and Terminations

1.2 RELATED SECTIONS

Section 26 05 32 - Conduit

Section 26 05 34 – Electrical Boxes and Fittings.

Section 26 05 29 - Supporting Devices and Seals

Section 26 05 53- Electrical Identification

1.3 REFERENCE STANDARDS

Comply with the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents. A listing of applicable reference standards is contained in Division 1.

NEMA WC 70 – Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

NEMA WC 70 – Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

1.4 SUBMITTALS

Submit shop drawings and product data under the provisions of Section 26 05 00.

1.5 PROJECT CONDITIONS

Verify that field measurements are as shown on Drawings.

Conductor sizes are based on copper.

If aluminum conductor is substituted for copper conductor, size to match circuit requirements for conductor ampacity and voltage drop {include required increases in conduit sizes.}

Wire and cable routing shown on Drawings is appropriate unless dimensioned. Route wire and cable as required to meet project conditions.

Where wire and cable routing is not shown, and destination only is indicated, determine exact routing and lengths required.

1.6 COORDINATION

Coordinate Work under provisions of Section 26 05 00.

Determine required separation between wiring and other work.

Determine routing to avoid interference with other work.

PART 2 - PRODUCTS

2.0 BUILDING WIRE

Thermoplastic-Insulated Building Wire: NEMA WC 70.

Rubber-Insulated Building Wire: NEMA WC 70.

Feeders and Branch Circuits: Copper, 600-volt, insulation, THHN/THWN, or XHHW. Conductors #10 AWG and larger shall be stranded. Conductors smaller than #10 shall be solid.

Control Circuits: Copper, stranded conductor 600-volt insulation, THHN/THWN, or XHHW.

2.1 METAL CLAD CABLE

Metal Clad Cable is only allowed to be utilized for connections to luminaires that are located within 6’ of the junction box serving power to the luminaire.

Description: ANSI/NFPA 70, Type MC.

Conductor: Copper.

Insulation Voltage Rating: 600 volts.

Insulation Temperature Rating: 75 degrees C.

Insulation Material: Thermoplastic and thermosetting.

Armor Material: Steel.

Armor Design: Interlocked metal tape.

Jacket: PVC jacket when installed in damp and wet locations.

Cable to be provided with a separate equipment grounding conductor sized per NEC.

2.2 REMOTE CONTROL AND SIGNAL CABLE

Control Cable for Class 1 Remote Control and Signal Circuits: Copper conductor, 600-volt insulation, rated 60 degree C, individual conductors twisted together, shielded, and covered with a PVC jacket.

Control Cable for Class 2 or Class 3 Remote Control and Signal Circuits: Copper conductor, 300-volt insulation, rated 60 degrees C, individual conductors twisted together, shielded, and covered with a PVC jacket; UL listed.

Plenum Cable for Class 2 or Class 3 Remote Control and Signal Circuits: Copper conductor, 300-volt insulation, rated 60 degrees C, individual conductors twisted together, shielded, and covered with a non-metallic jacket; UL listed for use in air handling ducts, hollow spaces used as ducts, and plenums.

Install all remote control and signal cables in cable tray, raceways, or supported every 4'-0" on bridal rings.

PART 3 - EXECUTION

3.0 GENERAL WIRING METHODS

Use no wire smaller than No. 12 AWG for power and lighting circuits, and no smaller than No. 16 AWG for control wiring.

Use No. 10 AWG conductor for 20 ampere, 120-volt branch circuit home runs longer than 75 feet, and for 20 ampere, 277-volt branch circuit home runs longer than 200 feet.

Place an equal number of conductors for each phase of a circuit in same raceway or cable.

Splice only in accessible junction or outlet boxes.

Neatly train and lace wiring inside boxes, equipment, and panelboards. Make temporary connections to panelboard devices with sufficient slack conductor to facilitate reconnections required for balancing loads between phases.

Conductors damaged during installation shall be replaced.

Install products in accordance with manufacturer's instructions.

3.1 WIRING INSTALLATION IN RACEWAYS

Pull all conductors into a raceway at the same time. Use UL listed wire pulling lubricant for pulling No. 4 AWG and larger wires.

Install wire in raceway after interior of building has been physically protected from the weather and all mechanical work likely to injure conductors has been completed.

Completely and thoroughly swab raceway system before installing conductors.

3.2 CABLE INSTALLATION

When approved install in interior partitions only and for flexible connection to luminaires. (Flexible connection not to exceed 6'-0".)

Use suitable cable fittings and connectors.

Cable shall not be used for branch circuit homeruns. Branch circuit homeruns shall be building wire in raceway.

Run concealed cable parallel and perpendicular to building elements at right angles. Parallel cable runs shall be run together. Run high and tight to structure. Coordinate cable runs with other trades.

Support cable every four feet and within 12 inches of every outlet box, junction box, cabinet, or fitting.

Cable shall not be used in emergency circuits.

Cable shall not be used as flexible connection to motors, transformers or other vibrating equipment.

Support cables above accessible ceiling, using spring metal clips or metal cable ties to support cables from structure. Do not rest cable on ceiling panels.

Provide protection for exposed cables where subject to damage.

3.3 WIRING CONNECTION AND TERMINATIONS

Splice only in accessible junction boxes.

For No. 8 AWG and smaller, use insulated spring wire connectors with plastic caps.

Use split bolt connectors for copper wire splices and taps, No. 6 AWG and larger. Tape un-insulated conductors and connectors with electrical tape to 150 percent of the insulation value of conductor.

Thoroughly clean wires before installing lugs and connectors.

Make splices, taps and terminations to carry full ampacity of conductors without perceptible temperature rise.

Terminate up to #10 AWG spare conductors with wire nuts. Use electrical tape for spare conductor #8 AWG and larger.

Terminate aluminum conductors with tin-plated, aluminum-bodied compression connectors only. Fill with anti-oxidant compound before installing conductor.

Use suitable reducing connectors or mechanical connector adaptors for connecting aluminum conductors to copper conductors.

Use solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and smaller.

Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.

3.4 FIELD QUALITY CONTROL

Field inspection and testing will be performed under provisions of Division 1.

Inspect wire and cable for physical damage and proper connection.

Torque test conductor connections and terminations to manufacturer's recommended values.

Perform continuity test on all power and equipment branch circuit conductors. Verify proper phasing connections.

3.5 WIRE AND CABLE INSTALLATION SCHEDULE

Concealed Interior Locations: Building wire in raceways or cable as approved herein.

If specified, cables may be used for luminaire connections and in interior partitions for branch circuits.

Exposed Interior Locations: Building wire in raceways.

Above Accessible Ceilings: Building wire in raceways or cable as approved herein.

Wet or Damp Interior Locations: Building wire in raceway.

Exterior Locations: Building wire in raceways.

Underground Locations: Building wire in raceways.

3.6 WIRE AND CABLE COLOR CODING

Wires No. 6 AWG and smaller shall be factory color coded. Wire No. 4 AWG and larger shall be color-coded with color tape 6-inch length of exposed ends, and at every accessible junction box on the branch circuit or feeder.

120/208 Volts	277/480 Volts
A = Black	A = Brown
B = Red	B = Orange
C = Blue	C = Yellow
Neutral = White	Neutral = Gray
Ground = Green	Ground = Green

Maintain the color coding throughout the system from panel to the last device on the branch circuit.

3.7 FIELD QUALITY CONTROL

Prior to energizing, all feeders from transformers, switchboards, and building service cables, are to be tested with a 500-volt insulation megohm meter to determine insulation resistance levels to assure requirements are fulfilled. All field test data is to be recorded and submitted. Test is to include meggering for one minute between conductors and between each conductor and ground. Cables are to be meggered after installation with cables disconnected at both ends. The values must be not less than as follows:

Conductor Size (AWG or MCM)	Resistance Megohms 1000 ft.)
#16 AWG to #8 AWG	200
#6 AWG to #2/0 AWG	100
#3/0 AWG to 500 KCMIL	50

END OF SECTION 26 05 19

SECTION 26 05 26

GROUNDING AND BONDING

PART 1 - GENERAL

1.0 RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.1 SUMMARY

Power System Grounding

Communication System Grounding

Electrical Equipment and Raceway Grounding and Bonding

1.2 REFERENCE STANDARDS

Comply with the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents.

NFPA Compliance: NFPA 70 "National Electrical Code (NEC).

UL Compliance: Applicable requirements of UL Standards Nos. 467 "Electrical Grounding and Bonding Equipment," and 869, "Electrical Service Equipment," pertaining to grounding and bonding of systems, circuits, and equipment. In addition, require compliance with UL Std 486A, "Wire Connectors". Grounding and bonding products which are to be UL-listed and labeled for their intended usage.

IEEE Compliance: Applicable requirements and recommended installation practices of IEEE Standards 80, 81, 141 and 142 pertaining to grounding and bonding of systems, circuits, and equipment.

1.3 SYSTEM DESCRIPTION

Ground the electrical service system neutral at service entrance equipment to metallic cold-water service, building steel and to supplementary grounding electrodes, as indicated on drawings.

Provide ground bars in electrical and technology rooms. Refer to construction documents for ground bar details and requirements.

Ground each separately derived system neutral to nearest metallic cold-water pipe 2-inch diameter or larger, building steel and where present to the referenced ground bar as shown on drawings.

Provide communications system grounding conductor at point of service entrance and connect to nearest referenced ground bar as shown on drawings.

Bond together system neutrals, service equipment enclosures, exposed non-current carrying metal parts of electrical equipment, metal raceway systems, grounding conductor in raceways and cables, receptacle ground connectors, piping systems and underground structural metal.

1.4 SUBMITTALS

Submit shop drawings under provisions of Section 26 05 00.

Indicate location of system grounding electrode connections, and routing of grounding electrode conductors.

Submit all field test reports.

PART 2 - PRODUCTS

2.0 MATERIALS

Ground Rods: Copper or copper-clad steel, 3/4-inch diameter, minimum length 10 feet.

Mechanical Grounding Connectors: For all grounding connections above grade.

Manufacturer: Burndy Electrical
Material: Copper.
Compression Type: Irreversible.
UL listed under Standard UL467.

Wire:

Material: Copper.
Size: As indicated on the drawings. When size is not indicated, size per Article 250 of NEC requirements.

Grounding Connection Accessories:

Electrical insulating tape, heat-shrinkable insulating tubing, welding materials, bonding straps, as recommended by accessories manufacturers for type service required.

2.1 Field Welding: Exothermic welded connections are required where grounding conductors connect to underground grounding conductors and to underground grounding electrodes, and for bonding to steel. All underground connection shall be exothermic welded.

PART 3 - EXECUTION

3.0 INSTALLATION

Provide a separate, insulated equipment grounding conductor in feeder and branch circuits. Terminate each ground conductor to the bushing and ground lug.

Connect grounding electrode conductors to metal water pipe using a suitable ground clamp. Make connections to flanged piping at street side of flange.

Supplementary Grounding Electrode: Use grounding mats, or driven ground rods, where indicated. Install ground rods in suitable recessed well; fill with gravel after connection is made.

Use minimum No. 6 AWG copper conductor for communications service grounding conductor. Leave 10-feet slack conductor at terminal board or cabinet.

Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torquing requirements are not indicated, connections are to be tightened to comply with tightening torque values specified in UL 486A to assure permanent and effective grounding.

Provide code-sized ground cable bonding jumpers, installed with ground clamps, across all conduit expansion couplings and fittings.

Route grounding connections, conductors to ground, and grounding conductors to protective devices in the shortest and straightest paths possible to minimize transient voltage rises.

Provide a corrosion-resistant finish to field connections, buried metallic bonding products, and where factory applied protective coatings have been destroyed, where subject to corrosive action.

Provide an equipment grounding conductor in all non-metallic conduits.

Provide an equipment grounding conductor in all flexible metallic conduits.

Grounding conductor in feeders and branch circuits extend ground conductor to switches, receptacle, equipment enclosures, equipment, and panels etc. and ground as required.

3.1 FIELD QUALITY CONTROL

Upon completion of installation of electrical grounding and bonding systems, the ground resistance shall be tested with an earth ground resistance tester in accordance with IEEE 81, "Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System". Where tests show resistance-to-ground is over values in Table 1 below, Contractor shall take appropriate action to reduce resistance to the values in Table 1, by driving additional ground rods; and then retest to demonstrate compliance. All results shall be recorded and submitted.

Table 1

Earth Ground Resistance to Equipment	Equipment (Ohms)
Pad Mount Transformer	5
Secondary Neutrals and Other Ground	10

END OF SECTION 26 05 26

SECTION 26 05 29

SUPPORTING DEVICES AND SEALS

PART 1 - GENERAL

1.0 RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.1 SUMMARY

Conduit and equipment supports.

Fastening hardware.

Wall and floor seals.

1.2 RELATED DOCUMENTS

Drawings, general and special conditions, Division 1 - General Requirements and other applicable technical specifications apply to work of this Section.

1.3 RELATED SECTIONS

Division 3 - Cast-in-Place Concrete. Concrete equipment pads.

Coordinate size, shape and location of concrete pads with Division 3.

Refer to Section 26 05 00 for coordination requirements.

1.4 REFERENCE STANDARDS

Comply with the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents. A listing of applicable reference standards is contained in Division 1.

1.5 QUALITY ASSURANCE

Support systems shall be adequate for weight of equipment and conduit, including wiring, which they carry.

PART 2 - PRODUCTS

2.0 MATERIAL

Support Channel: Galvanized or painted steel for non-corrosive environment.

Hardware: Corrosion-resistant.

PART 3 - EXECUTION

3.0 INSTALLATION

Fasten hanger rods, conduit clamps, and outlet and junction boxes to building structure using precast insert system, expansion anchors, preset inserts, or beam clamps. Do not use spring steel clips and clamps; however, caddy fasteners are accepted.

Use toggle bolts or hollow wall fasteners in hollow masonry, plaster, or gypsum board partitions and walls; expansion anchors or preset inserts in solid masonry walls; self-drilling anchors or expansion anchor on concrete surfaces; sheet metal screws in sheet metal studs; and wood screws in wood construction.

Do not fasten supports to piping, ductwork, mechanical equipment, or conduit.

Do not drill structural steel members.

Fabricate supports from structural steel or steel channel, rigidly welded or bolted to present a neat appearance. Use hexagon head bolts with spring lock washers under all nuts.

Install all free-standing electrical equipment on a 4-inch concrete housekeeping pad.

Install surface-mounted cabinets and panelboards with minimum of four anchors. Surface mounted panelboards to be supported with Unistrut from floor to ceiling structure. Mounting of panelboards directly to drywall surfaces is not acceptable.

Bridge studs top and bottom with channels to support flush-mounted cabinets and panelboards in stud walls.

Where conduit penetrates fire-rated walls, concrete and/or masonry walls and floors, it shall be sleeved. Seal opening around conduit with UL listed foamed silicone elastomer compound.

Where conduit penetrates waterproofed floors or exterior walls subject to entry of moisture, provide pipe sleeves two sizes larger than conduit, suitably flashed or sealed where appropriate. Seal annular space around conduit with UL listed foamed silicone elastomer compound.

Route conduit through roof openings for piping and ductwork where possible; otherwise, route through roof jack with pitch pocket.

No suspended conduit or box supports shall be less than 1/4-inch diameter steel rod. Rod used as pedestal support is not acceptable. The contractor shall not use tie wire or wire of any type to support conduits, junction boxes or pull boxes.

No more than five (5) 1/2-inch conduits, three (3) 3/4-inch conduits or two (2) 1-inch conduits shall be supported on a single 1/4-inch diameter steel rod.

All conduits shall be supported by approved hangers. Supports installed and used by other trades such as duct hangers, pipe hangers, ceiling hangers, etc. shall not be used for conduit support. No conduit shall be hung from air handling duct of any type. Electrical conduit systems "shall stand alone."

All light luminaires shall be independently supported at opposite corners from structural steel or from trapeze supported from structural steel by electrical contractor.

Wall-mounted luminaires shall be supported from building structure with approved backing support to prevent any damage to the wall.

Concrete anchors shall not be used to suspend heavy electrical loads such as electrical switch panels or four-inch and larger conduits. Anchors shall be designed to support conduits and cable tray when full fitted to maximum capacity with cables.

3.1 EQUIPMENT BASES

Provide equipment pad bases of concrete type, construction, and finish as herein specified. Bases shall be of dimensions indicated or, where not specifically indicated or specified, dimensions shall be 4 inches height with width and length providing 4 inches of projection of base beyond outline dimension of supported equipment.

Concrete shall be Class 3000, prepared in conformity with ACI 301, ASTM C 33, and ASTM C 94, as applicable. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping, using equipment and procedures for consolidation of concrete in accordance with ACI 309. Perform consolidation so that concrete is thoroughly worked around reinforcement and other embedded items and into corners. Perform curing of concrete by moist curing, by moisture-retaining cover curing, or by combinations thereof, as directed or approved.

Provide oiled wood forms for concrete placement, adequately braced to ensure straight and vertical sides for bases. Finished bases shall provide a 3/4-inch chamfer at all exposed edges. Except where vibration attenuating base mountings are specified, provide No. 4 dowels (conforming to ASTM A 615, Grade 60), grouted into place, for anchorage of bases to substrate for all applications for which imposed strains or dynamic forces produced by equipment operation introduce the possibility of displacement of bases. Spacing of dowels shall be not less than 24 inches o.c., with a minimum of 4 dowels for each base.

Bases where indicated shall be reinforced by installation of 6 x 6 No. 8 AWG welded wire fabric conforming to ASTM A 185. Apply measures, during concrete placement, to ensure that fabric remains vertically centered in bases.

Bring slab surfaces to correct level with straightedge and strikeoff. Do not disturb slab surfaces prior to beginning finishing operations. Float finish surfaces and provide steel trowel final finish.

For all equipment to be installed on concrete bases or other concrete construction, provide templates, anchor bolts, and accessories as required. When installing equipment, set equipment into final position, shim equipment bases, skids or rails for level positioning, and install non-shrink grout for uniform support, and securely bolt into final position.

END OF SECTION 26 05 29

SECTION 26 05 32
CONDUIT

PART 1 - GENERAL

1.0 RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.1 SECTION INCLUDES

Metal Conduit

Flexible Metal Conduit

Liquidtight Flexible Metal Conduit

Electrical Metallic Tubing

Nonmetallic Conduit

Fittings and Conduit Bodies

1.2 RELATED SECTIONS

Division 1 - Cutting and Patching.

Division 2 - Trenching: Excavation and backfill for conduit and utilities on site.

Division 3 - Cast-In-Place Concrete: Protective envelope for underground conduit installations.

Division 7 - Sheet Metal Flashing and Trim

Section 26 05 26 - Grounding and Bonding

Section 26 05 29 - Supporting Devices and Seals

Section 26 05 34 - Electrical Boxes and Fittings

Section 26 05 53 - Electrical Identification

1.3 REFERENCES

ANSI C80.1 - Rigid Steel Conduit, Zinc Coated.

ANSI C80.3 - Electrical Metallic Tubing, Zinc Coated.

ANSI/NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.

ANSI/NFPA 70 - National Electrical Code.

NECA - "Standard of Installation".

NEMA RN 1 - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.

NEMA TC 2 - Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80).

NEMA TC 3 – PVC Fittings for Use with Rigid PVC Conduit and Tubing.

1.4 DESIGN REQUIREMENTS

Conduit Size: ANSI/NFPA 70.

1.5 PROJECT RECORD DOCUMENTS

Submit under provisions of Section 26 05 00.

Accurately record actual routing of conduits larger than two (2) inches or larger, regardless of location (i.e., above ceiling, below slab, etc.). Dimension from building columns.

Accurately record actual routing of all conduits installed in and under the slab. Dimension from the building columns.

1.6 DELIVERY, STORAGE, AND HANDLING

Deliver, store, protect, and handle products under provisions of Section 26 05 00 and Division 1.

Accept conduit on site. Inspect for damage.

Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

Protect PVC conduit from sunlight.

1.7 PROJECT CONDITIONS

Verify that field measurements are as shown on Drawings.

Verify routing and termination locations of conduit prior to rough-in.

Conduit routing is shown on Drawings in approximate locations unless dimensioned. Route as required to complete wiring system and to coordinate with the work of other trades.

PART 2 - PRODUCTS

2.0 CONDUIT REQUIREMENTS

Minimum Size, unless otherwise specified:

Homeruns:

3/4-Inch above accessible ceilings.
3/4-Inch above inaccessible ceilings and in concrete slab.
1-Inch below grade and below slab on grade.

Branch Circuits after the first junction point: 3/4-Inch C unless otherwise specified.

Underground Installations:

More than 5-Feet from Foundation Wall: Use PVC Schedule 40 nonmetallic conduit, except as otherwise noted.
Within 5-Feet from Foundation Wall: Use rigid steel plastic coated conduit.

In or Under Slab on Grade: Use PVC Schedule 40 nonmetallic conduit.
Minimum Size: 1-Inch.

Outdoor Locations, Above Grade: Use rigid steel conduit.

In Slab Above Grade:

Use PVC Schedule 40 nonmetallic conduit, unless otherwise specified.
Maximum Size Conduit in Slab: 3/4-Inch or as permitted by the Structural Engineer, based on field conditions.

Wet and Damp Locations: Use rigid steel conduit if subject to physical damage. Thickwall nonmetallic conduit in areas not subject to physical damage and acceptable to the local authority.

Dry Locations:

Concealed: Use electrical metallic tubing.
Exposed: Use rigid steel conduit if subject to damage below 8-feet, otherwise use electrical metallic tubing.

2.1 METAL CONDUIT

Rigid Steel Conduit: ANSI C80.1.

Intermediate Metal Conduit (IMC): Rigid steel.

Fittings and Conduit Bodies: ANSI/NEMA FB 1; material to match conduit.

2.2 PVC COATED METAL CONDUIT

Description: NEMA RN 1; rigid steel conduit with external PVC coating,20 mil thick.

Fittings and Conduit Bodies: ANSI/NEMA FB 1; steel fittings with external PVC coating to match conduit.

2.3 FLEXIBLE METAL CONDUIT

Description: Interlocked steel construction.

Fittings: ANSI/NEMA FB 1.

2.4 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

Description: Interlocked steel construction with PVC jacket.

Fittings: ANSI/NEMA FB 1.

2.5 ELECTRICAL METALLIC TUBING (EMT)

Description: ANSI C80.3; galvanized tubing.

Fittings and Conduit Bodies: ANSI/NEMA FB 1; steel, compression or set screw type.

2.6 NONMETALLIC CONDUIT

Description: NEMA TC 2; Schedule 40 PVC.

Fittings and Conduit Bodies: NEMA TC 3.

PART 3 - EXECUTION

3.0 INSTALLATION

Install conduit in accordance with NECA "Standard of Installation".

Install nonmetallic conduit in accordance with manufacturer's instructions.

Arrange supports to prevent misalignment during wiring installation.

Support conduit using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.

Group related conduits; support using conduit rack. Construct rack using steel channel, provide space on each for 25 percent additional conduits.

Fasten conduit supports to building structure and surfaces under provisions of Section 26 05 29.

Do not support conduit with wire or perforated pipe straps. Remove wire used for temporary supports.

Do not attach conduit to ceiling support wires.

Arrange conduit to maintain headroom and present neat appearance.

Route exposed conduit parallel and perpendicular to walls.

Route conduit installed above accessible ceilings parallel and perpendicular to building elements and walls.

Route conduit in and under slab from point-to-point. Dimension from building columns.

Do not cross conduits in slab except with written approval from the Structural Engineer.

Routing conduits parallel in the slab is prohibited except with written approval from the Structural Engineer.

Maintain adequate clearance between conduit and piping.

Maintain 12-inch clearance between conduit and surfaces with temperatures exceeding 104 degrees F.

Cut conduit square using saw or pipe cutter; de-burr cut ends.

Bring conduit to shoulder of fittings; fasten securely.

Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for twenty (20) minutes, minimum.

Use conduit hubs or sealing locknuts to fasten conduit to sheet metal boxes in damp and wet locations and to cast boxes.

Install no more than equivalent of four 90-degree bends between boxes. Use conduit bodies to make sharp changes in direction, as around beams. Use hydraulic one-shot bender to fabricate or factory elbows for bends in metal conduit larger than 2-inch size.

Avoid moisture traps; provide junction box with drain fitting at low points in conduit system.

Provide suitable fittings to accommodate expansion and deflection where conduit crosses, control and expansion joints.

Provide suitable pull string in each empty conduit except sleeves and nipples.

Use suitable caps to protect installed conduit against entrance of dirt and moisture.

Ground and bond conduit under provisions of Section 26 05 26.

Identify conduit under provisions of Section 26 05 53.

Transition from underground nonmetallic conduit to above grade metal conduit or electrical metallic tubing shall be made in or below the slab. The transition between nonmetallic conduit and above grade conduit shall be made with a rigid steel, plastic coated elbow.

3.1 INTERFACE WITH OTHER PRODUCTS

Install conduit to preserve fire resistance rating of partitions and other elements, using approved materials and methods.

Route conduit through roof openings for piping and ductwork or through suitable roof jack with pitch pocket. Coordinate location with roofing installation specified.

END OF SECTION 26 05 32

SECTION 26 05 33
SURFACE RACEWAYS

PART 1 - GENERAL

1.0 RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

PART 2 - PRODUCTS

2.0 SURFACE METAL RACEWAY

Manufacturers:

Panduit Corp.
Square-D Company.
Hubbell, Inc.
Wiremold Company.
Substitutions: Under provisions of Section 26 05 00.

2.1 SURFACE METAL RACEWAY

Description: Sheet metal channel with fitted cover, suitable for use as surface metal raceway.

Size: As shown on Drawings.

Finish: Gray enamel.

Fittings, Boxes, and Extension Rings: Furnish manufacturer's standard accessories.

2.2 MULTIOUTLET ASSEMBLY

Manufacturers:

Wiremold Company
Hubbell, Inc.
Substitutions: Under provisions of Section 26 05 00.

Multioutlet Assembly: Sheet metal channel with fitted cover, with pre-wired receptacles, suitable for use as multioutlet assembly.

Size: As indicated on Drawings.

Receptacles: Provide covers and accessories to accept receptacles specified in Section 26 27 26.

Receptacle Spacing: As indicated on Drawings.

Receptacle Color: As specified in Section 26 27 26.

Channel Finish: Gray enamel.

Fittings: Furnish manufacturer's standard couplings, elbows, and connectors.

2.3 WIREWAY

Manufacturers:

Cooper B-Line
Wiremold Company
Square-D
Hoffman
Substitutions: Under provisions of Section 26 05 00.

General purpose type wireway.

Knockouts: Manufacturer's standard.

Size: As indicated on Drawings.

Description: Cover: Screw cover with full gasketing.

Connector: Flanged.

Fittings: Lay-in type with removable top, bottom, and side; captive screws.

Finish: Rust inhibiting primer coating with gray enamel finish

PART 3 - EXECUTION

3.0 INSTALLATION

Install products in accordance with manufacturer's instructions.

Use flat-head screws, clips, and straps to fasten raceway channel to surfaces. Mount plumb and level.

Use suitable insulating bushings and inserts at connections to outlets and corner fittings.

Wireway Supports: Provide steel channel as specified in Section 26 05 29.

Close ends of wireway and unused conduit openings.

Ground and bond raceway and wireway under provisions of Section 26 05 26.

END OF SECTION 26 05 33

SECTION 26 05 34

ELECTRICAL BOXES AND FITTINGS

PART 1 - GENERAL

1.0 RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.1 SUMMARY

Wall and Ceiling Outlet Boxes

Floor Boxes

Pull and Junction Boxes

1.2 RELATED DOCUMENTS

Drawings, general and special conditions, Division 1 - General Requirements and other applicable technical specifications apply to work of this Section.

1.3 RELATED SECTIONS

Division 7 - Firestopping.

Division 8 - Access Doors: Wall and ceiling access doors.

Section 26 27 26 - Wiring Devices: Service fittings and fire-rated poke-through fittings for floor boxes.

Section 26 05 35 - Cabinets and Enclosures.

Section 26 05 80 – Equipment Wiring Systems.

1.4 REFERENCE STANDARDS

Comply with the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents. A listing of applicable reference standards is contained in Division 1.

ANSI/NEMA FB 1 - Fittings and Supports for Conduit and Cable Assemblies.

ANSI/NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers and Box Supports.

ANSI/NFPA 70 - National Electrical Code.

NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

1.5 PROJECT CONDITIONS

Verify field measurements are as shown on Drawings.

Verify locations of floor boxes and outlets prior to rough-in.

Electrical boxes are shown on Drawings in approximate locations unless dimensioned. Install at location required for box to serve intended purpose. Include installation within 10-feet of location shown. Refer to Architectural Drawings.

PART 2 - PRODUCTS

2.0 OUTLET BOXES

Sheet Metal Outlet Boxes: ANSI/NEMA OS 1; galvanized steel, with 2-inch male luminaire studs where required.

Cast Boxes: NEMA FB 1, Type FD, cast ferroalloy. Provide gasketed cover by box manufacturer. Provide threaded hubs.

2.1 FLOOR BOXES

Floor Boxes: ANSI/NEMA OS 1 or NEMA FB 1, fully adjustable.

2.2 PULL AND JUNCTION BOXES

Sheet Metal Boxes: NEMA OS 1; galvanized steel.

Sheet Metal Boxes Larger than 12-Inches in Any Dimension: Hinged enclosure in accordance with Section 26 05 35.

Surface-Mounted Cast Metal Box: NEMA 250, Type 6; flat-flanged, surface-mounted junction box.

Material: Galvanized cast iron.
Cover: Furnish with ground flange, neoprene gasket, and stainless-steel cover screws.

PART 3 - EXECUTION

3.0 INSTALLATION

Install electrical boxes as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections and compliance with regulatory requirements.

Install electrical boxes to maintain headroom and to present neat mechanical appearance.

Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only. All pull boxes and junction boxes are to be accessible and not in conflict with mechanical equipment.

Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed luminaire.

Install boxes to preserve fire resistance rating of partitions and other elements, using materials and methods under the provisions of Division 7.

Align adjacent wall-mounted outlet boxes for switches, thermostats, and similar devices with each other.

Use flush mounting outlet boxes in finished areas.

Do not install flush mounting boxes back-to-back in walls; provide minimum 6-inch separation. Provide minimum 12-inch separation between back-to-back boxes in acoustic-rated walls.

Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.

Use stamped steel bridges to fasten flush mounting outlet box between studs.

Install flush mounting box without damaging wall insulation or reducing its effectiveness.

Use adjustable steel channel fasteners for hung ceiling outlet box.

Do not fasten boxes to ceiling support wires.

Support boxes independently of conduit, except cast box that is connected to two (2) rigid metal conduits both supported within 12 inches of box.

Use gang box where more than one (1) device is mounted together. Do not use sectional box.

Use gang box with plaster ring for single device outlets.

Use cast outlet box in exterior locations exposed to the weather and wet locations.

Use cast floor boxes for installations in slab on grade; formed steel boxes are acceptable for other installations.

Set floor boxes level.

Large Pull Boxes: Boxes larger than 100 cubic inches in volume or 12-inches in any dimension.

Interior Dry Locations: Use hinged enclosure under provisions of Section 26 05 35.
Other Locations: Use surface-mounted cast iron box.

Minimum junction and pull box size 4-11/16" x 4-11/16" x 2-1/4".

Minimum outlet box size 4" x 4" x 1-1/2".

Minimum telephone outlet box size 4-11/16" x 4-11/16" x 2-1/4".

Minimum junction box size for fire alarm pull stations, control module, monitor module, 4" x 4" x 2-3/4". Provide plaster ring at all pull station locations.

3.1 INTERFACE WITH OTHER PRODUCTS

Coordinate installation of outlet box for products furnished under other sections.

Coordinate locations and sizes of required access doors with Division 8.

Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.

Coordinate mounting heights and locations of outlets mounted above counters, benches and backsplashes.

Position outlet boxes to locate luminaires as shown on reflected ceiling plan.

3.2 ADJUSTING

Adjust floor box flush with finish flooring material.

Adjust flush-mounting outlets to make front flush with finished wall material.

Install knockout closure in unused box openings.

END OF SECTION 26 05 34

SECTION 26 05 35

CABINETS AND ENCLOSURES

PART 1 - GENERAL

1.0 RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.1 SECTION INCLUDES

Hinged cover enclosures.

Cabinets.

Terminal blocks.

Accessories.

1.2 RELATED SECTIONS

Section 26 05 29 - Supporting Devices and Seals

1.3 REFERENCES

NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

NEMA ICS 4 - Terminal Blocks for Industrial Control Equipment and Systems.

ANSI/NFPA 70 - National Electrical Code.

1.4 SUBMITTALS

Submit under provisions of Section 26 05 00.

Product Data: Provide manufacturer's standard data for enclosures and cabinets.

Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of products.

1.5 EXTRA MATERIALS

Provide two of each cabinet key.

PART 2 - PRODUCTS

2.0 HINGED COVER ENCLOSURES

Construction: NEMA 250, Type 1 steel enclosure.

Covers: Continuous hinge, held closed by flush latch operable by key.

Provide interior plywood panel for mounting terminal blocks and electrical components, finish with matte white enamel.

Enclosure Finish: Manufacturer's standard enamel.

2.1 CABINETS

Boxes: Galvanized steel with removable end walls.

Box Size: As indicated

Backboard: Provide 3/4-inch-thick plywood backboard for mounting terminal blocks. Paint matte white enamel.

Fronts: Steel, surface type with concealed hinge, and flush lock keyed to match branch circuit panelboard. Finish with gray baked enamel.

Knockouts: As required

Provide metal barriers to separate compartments containing control wiring operating at less than 50 volts from power wiring.

Provide accessory feet for free-standing equipment.

2.2 TERMINAL BLOCKS

Terminal Blocks: ANSI/NEMA ICS 4.

Power Terminals: Unit construction type with closed back and tubular pressure screw connectors, rated 600 volts.

Signal and Control Terminals: Modular construction type, suitable for channel mounting, with tubular pressure screw connectors, rated 300 volts.

Provide ground bus terminal block, with each connector bonded to enclosure.

2.3 FABRICATION

Shop assemble enclosures and cabinets housing terminal blocks or electrical components in accordance with ANSI/NEMA ICS 6.

Provide conduit hubs on enclosures.

Provide protective pocket inside front cover with schematic diagram, connection diagram, and layout drawing of control wiring and components within enclosure.

PART 3 - EXECUTION

3.0 EXAMINATION

Verify that surfaces are ready to receive Work.

3.1 INSTALLATION

Install Products in accordance with manufacturer's instructions.

Install enclosures and boxes plumb. Anchor securely to wall and structural supports at each corner.

Install cabinet fronts plumb.

END OF SECTION 26 05 35

SECTION 26 05 53
ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.0 RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.1 SUMMARY

Buried and Duct Bank Warnings

Electrical Power, Control and Communication Conductors and Conduit

Operational Instructions and Warnings

Danger Signs

Equipment/System Identification Signs

1.2 RELATED SECTIONS

Division 9 - Painting.

1.3 REFERENCE STANDARDS

Comply with the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents. A listing of applicable reference standards is contained in Division 1.

1.4 QUALITY ASSURANCE

ANSI Compliance: Applicable requirements of ANSI A13.1, "Piping and Piping Systems".

FS Compliance: Applicable requirements of FS L-P-387 "Plastic Sheet, Laminated, Thermosetting (for designation plates)".

UL Compliance: Applicable requirements of UL Standard 969, "Marking and Labeling Systems," pertaining to electrical identification systems.

NEMA Compliance: Applicable requirements of NEMA Standard Nos. WC-1 and WC-2 pertaining to identification of power and control conductors.

Comply with "OSHA" sign standards for danger, caution, warning, etc.

1.5 SUBMITTALS

Submit product data under provisions of Division 1.

Include schedule for all specified applications of electrical identification.

PART 2 - PRODUCTS

2.0 ELECTRICAL IDENTIFICATION MATERIALS

General: The manufacturer's standard products of categories and types required are to be used for each application.

Underground Type Plastic Line Marker:

Manufacturer's standard permanent, bright-colored, continuous-printed plastic tape, intended for direct-burial service; not less than 6-inches wide x 4 mils thick. Printing is required on tape, which most accurately indicates type of service.
Color: Yellow

Cable/Conductor Identification Bands:

For cables smaller than No. 2/0 manufacturer's standard vinyl-cloth self-adhesive cable/conductor markers of wrap-around type, either pre-numbered plastic-coated type, or write-on type with clear plastic self-adhesive cover flap are to be used and numbered to show circuit identification.
For cables No. 2/0 AWG and larger, heat shrink sleeving is to be used for phase color coding.

Plasticized Tags:

Manufacturer's standard preprinted or partially preprinted accident-prevention and operational tags, on plasticized card stock with matte finish suitable for writing, approximately 3-1/4-inch x 5-5/8-inch, with brass grommets and wire fasteners, and with appropriate preprinted wording including large-size primary wording, e.g., DANGER, CAUTION, DO NOT OPERATE.

Baked Enamel Danger Signs:

Manufacturer's standard "DANGER" signs of baked enamel finish on .40 aluminum; of standard Red, Black and White graphics; 14-inch x 10-inch size except where 10-inch x 7-inch is the largest size which can be applied where needed; with recognized standard explanation wording, e.g., XXXX VOLTS, KEEP AWAY, BURIED CABLE, DO NOT TOUCH SWITCH, etc.

Engraved Plastic-Laminate Signs:

Engraved stock melamine plastic laminate, complying with FS L-P-387, in sizes and thicknesses indicated, engraved with engraver's standard letter style of sizes and wording indicated, White face and Black core (Black letters on a White background) except as otherwise required (emergency power and fire alarm shall be Red with White letters), punched for mechanical fastening with a minimum of two (2) screws.
Thickness: 1/16-Inch, for units up to 20 square inches or 8-inch length; 1/8-inch for larger units.
Fasteners: A minimum of two (2) self-tapping stainless-steel screws.
Minimum letter height shall be as follows:

1/4-Inch:

Panelboard name.
Switchboard name.
Transformer name.
Transformer switch name.

System control panel name.
Voltage rating.
Ampere rating.
Source circuit ("Fed from Normal or Generator").
Individual circuit breaker number and load name.
Individual switch circuit number and load name.
Individual motor starter circuit number and load name.
Individual indicating light function.
Individual pushbutton function.
Individual selector switch functions.

Lettering and Graphics:

Names, abbreviations, and other designations used in electric identification work are to be coordinated with corresponding designation shown, specified or scheduled. Numbers, lettering and wording as required or as recommended by manufacturer or as required for proper identification and operation/maintenance of electrical systems and equipment.

Adhesive Marking Tape for Device Cover Plates:

Avery-type or equal with 3/16-inch minimum height letters. Labels shall have black letters on clear labels for normal and red letters on clear labels for emergency. Embossed Dymo-Tape labels are not acceptable.

PART 3 - EXECUTION

3.0 APPLICATION AND INSTALLATION

General Installation Requirements:

Regulations: Governing regulations and requests of governing authorities are to be complied with for identification of electrical work.

Underground Conduit and Ductbank Identification:

During back-filling/top-soiling of each exterior underground conduit and ductbank, a continuous underground-type plastic line marker, located directly over conduit or ductbank at 12-inches below finished grade or 4-inches below paving, shall be provided.

Cable/Conductor Identification:

The application of cable/conductor identification, with circuit number, on each cable/conductor in each box/enclosure/cabinet where wires of more than one circuit or communication/signal system are present is required. The identification is to match the marking system used in panelboards, shop drawings, contract documents, and similar previously established identification for project's electrical work.

Junction Box and Pull Box Identification:

On the Cover of each junction box and pull box: The circuit number(s) of the enclosed conductors are to be legibly written with a Black permanent ink broad tip marking pen and the system identified for FA (Fire Alarm) EM (Emergency) PA (Public Address), S (Security) TC (Temperature Control).
Covers for emergency system junction boxes and pull boxes shall be painted Red.
Covers for the Fire Alarm System junction boxes and pull boxes shall be painted Red.

Operational Identification and Warnings:

Wherever required to ensure safe and efficient operation and maintenance of electrical systems, and electrically connected mechanical systems and general systems and equipment, including prevention of misuse of electrical facilities by unauthorized personnel, self-adhesive plastic signs or similar equivalent identification, instruction or warnings on switches, outlets and other controls, devices and covers of electrical enclosures shall be provided. Where detailed instructions or explanations are needed, provide plasticized tags with clearly written messages adequate for intended purposes.

Caution Signs:

The following caution sign is to be provided for all circuit breakers and switchboards where turning off a circuit will automatically start an emergency operation:

"CAUTION TURNING OFF THIS CIRCUIT WILL
AUTOMATICALLY START EMERGENCY OPERATION."

The following caution sign is to be provided for all automatic transfer switches, switches, circuit breakers, equipment, and emergency panels that are energized by the emergency power system:

"CAUTION AUTOMATICALLY ENERGIZED BY
EMERGENCY POWER SUPPLY SYSTEM."

Equipment/System Identification:

An engraved plastic-laminated sign is to be provided on each major unit of electrical equipment in the building; including central or master unit of each electrical system including communication/control/signal/alarm systems unless unit is specified with its own self-explanatory identification or signal system. Except as otherwise indicated, provide single line of text, letter height as specified, black lettering on white field. Provide text matching terminology and numbering of the contract documents and shop drawings. The sign shall include unit designation, source circuit number, circuit voltage, and other data specifically indicated. Also, the sign shall indicate normal source circuit number ("Fed from . . .") and emergency source circuit number when the equipment is a transfer switch or fed directly from a transfer switch. Include signs for each unit of the following categories of electrical work:

Switchboards, panelboards (include main bus ampacity on sign), electrical cabinets and enclosures.

Transformers

Access panel/doors to electrical facilities.
Disconnect switches.
Push buttons, selector switches, indicating lights. (Circuit number and voltage not required on sign).
Power transfer equipment: Contactors and transfer switches.
Power generating units.

The installation of signs is required at locations indicated or, where not otherwise indicated, at location for best convenience of viewing without interference with operation and maintenance of equipment. The sign shall be secured to the substrate with fasteners, except use adhesive where fasteners should not or cannot penetrate substrate.

For panelboards, provide framed, typed circuit schedules (label all spares and spaces in pencil) with explicit description and identification of items controlled by each individual breaker.

Provide tape labels for identification of individual receptacles and switches. Locate tape on front of plate and indicate associated source panelboard and circuit number.

END OF SECTION 26 05 53

SECTION 26 05 73
ELECTRICAL STUDIES

PART 1 - GENERAL

1.0 SUMMARY

Fault current calculation, coordination of overcurrent devices, and arc-flash information indicated in Construction Documents is per basis of design including equipment and assumed feeder lengths, and shall be considered preliminary. Contractor shall provide computer-based study for building electrical distribution and overcurrent protection based on submittal equipment and planned installation conditions including Contractor proposed feeder routing and lengths. The Contractor shall submit study with the distribution equipment and overcurrent protection submittals. Equipment AIC ratings shall be revised on submittals from that indicated on Construction Documents as needed and identify revision in such submittals due to study results. The Contractor shall revise study and equipment AIC ratings as needed during construction and after submittals acceptance due to changes resulting from as-built conditions.

Contractor shall provide arc-flash hazard warning labeling on equipment per NEC based on final study results. Labels shall comply with Owner standards.

As a result of the Contractor provided study, the Contractor shall coordinate with Mechanical Contractor to assure that mechanical equipment AIC ratings are above fault currents of study. Electrical contractor shall provide local fused disconnect switches for conditions where higher AIC ratings of mechanical equipment is not available to exceed study fault current results, and let-through of fuses and AIC rating of fused disconnect switches can resolve the condition.

Section includes a computer-based, fault current study to determine the minimum interrupting capacity of circuit protective devices.

Section includes computer-based, overcurrent protective device coordination studies to determine overcurrent protective devices and to determine overcurrent protective device settings for selective tripping.

Section includes a computer-based, arc-flash study to determine the arc-flash hazard distance and the incident energy to which personnel could be exposed during work on or near electrical equipment.

1.1 DEFINITIONS

Field Adjusting Agency: An independent electrical testing agency with full-time employees and the capability to adjust devices and conduct testing indicated and that is a member company of NETA.

Power System Analysis Software Developer: An entity that commercially develops, maintains, and distributes computer software used for power system studies.

Power Systems Analysis Specialist: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located.

1.2 SUBMITTALS

Product Data:

For computer software program to be used for studies.
Submit the following:

Study input data, including completed computer program input data sheets.
Study and equipment evaluation report; signed, dated, and sealed by a qualified professional engineer.

Submit study report for action with distribution equipment and overcurrent protection submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Engineer for preliminary submittal of sufficient study data with distribution equipment and overcurrent protection submittal to ensure that selection of devices and associated characteristics is satisfactory.
Study report shall be revised and resubmitted based on action resulting from distribution equipment and overcurrent protection submittals.

Revised one-line diagram, reflecting field investigation results and results of fault current study.

Qualification Data:

For Power Systems Analysis Software Developer.
For Power System Analysis Specialist.
For Field Adjusting Agency.

Product Certificates:

For fault current and coordination study software, certifying compliance with IEEE 399.
For arc-flash study software, certifying compliance with IEEE 1584 and NFPA 70E.

Include with Operation and Maintenance Manual:

Final one-line diagram.
Final Study Report.
Study data files.
List of protective device settings.
Time-current coordination curves.
Arc-Flash maintenance procedures for use by Owner's personnel for compliance with NFPA 70E.
Power System Data:

Available fault current at line terminals of equipment which are Contractor’s responsibility, including data from utility.

1.3 QUALITY ASSURANCE

Study shall be performed using commercially developed and distributed software designed specifically for power system analysis.

Software algorithms shall comply with requirements of standards and guides specified in this Section.

Manual calculations are unacceptable.

Power System Analysis Software Qualifications:

Computer program shall be designed to perform fault current studies or have a function, component, or add-on module designed to perform fault current studies.
Computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

Power Systems Analysis Specialist Qualifications: Professional engineer licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

Study Certification: Study Report shall be signed and sealed by Power Systems Analysis Specialist.

Field Adjusting Agency Qualifications:

Employer of a NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification responsible for all field adjusting of the Work.
A member company of NETA.
Acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.0 POWER SYSTEM ANALYSIS SOFTWARE DEVELOPERS

Software Developer:

SKM Systems Analysis, Inc.

Fault-Current: Comply with IEEE 399 and IEEE 551.

Coordination: Comply with IEEE 242 and IEEE 399.

Arc-Flash: Comply with IEEE 1584 and NFPA 70E.

Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.

Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

2.1 STUDY REPORT CONTENTS

Executive summary of study findings.

Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.

One-line diagram of modeled power system, showing the following:

Protective device designations and ampere ratings.
Conductor types, sizes, and lengths.
Transformer kilovolt ampere (kVA) and voltage ratings.

Motor and generator designations and kVA ratings.
Switchgear, switchboard, motor-control center, and panelboard designations and ratings.
Derating factors and environmental conditions.
Any revisions to electrical equipment required by the study.

Protective Device Evaluation:

Evaluate equipment and protective devices and compare to available fault currents. Verify that equipment withstand ratings exceed available fault current at equipment installation locations.
Tabulations of circuit breaker, fuse, and other protective device ratings versus calculated fault current duties.
For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in standards to 1/2-cycle symmetrical fault current.
Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

Fault Current Study Input Data:

One-line diagram of system being studied.
Power sources available.
Manufacturer, model, and interrupting rating of protective devices.
Conductors.
Transformer data.

Fault Current Study Output Reports:

Low-Voltage Fault Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

Voltage.
Calculated fault-current magnitude and angle.
Fault-point X/R ratio.
Equivalent impedance.

Momentary Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

Voltage.
Calculated symmetrical fault-current magnitude and angle.
Fault-point X/R ratio.
Calculated asymmetrical fault currents:

Based on fault-point X/R ratio.
Based on calculated symmetrical value multiplied by 1.6.
Based on calculated symmetrical value multiplied by 2.7.

Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

Voltage.
Calculated symmetrical fault-current magnitude and angle.
Fault-point X/R ratio.
No AC Decrement (NACD) ratio.

Equivalent impedance.
Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

Protective Device Coordination Study:

Report recommended settings of protective devices, ready to be applied in the field. Use manufacturer's data sheets for recording the recommended setting of overcurrent protective devices when available.

Phase and Ground Relays:

Device tag.
Relay current transformer ratio and tap, time dial, and instantaneous pickup value.
Recommendations on improved relaying systems, if applicable.

Circuit Breakers:

Adjustable pickups and time delays (long time, short time, and ground).
Adjustable time-current characteristic.
Adjustable instantaneous pickup.
Recommendations on improved trip systems, if applicable.

Fuses: Show current rating, voltage, and class.

Time-Current Coordination Curves: Determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:

Device tag and title, one-line diagram with legend identifying the portion of the system covered.
Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.
Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
Plot the following listed characteristic curves, as applicable:

Power utility's overcurrent protective device.
Low-voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
Low-voltage equipment circuit-breaker trip devices, including manufacturer's tolerance bands.
Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves.
Cables and conductors damage curves.
Ground-fault protective devices.
Motor-starting characteristics and motor damage points.
Generator fault current decrement curve and generator damage point.
The largest feeder circuit breaker in each and panelboard.

Arc-Flash Study Output Reports:

Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each equipment location included in the report:

Voltage.
Calculated symmetrical fault-current magnitude and angle.
Fault-point X/R ratio.
No AC Decrement (NACD) ratio.
Equivalent impedance.
Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

Incident Energy and Flash Protection Boundary Calculations:

Arcing fault magnitude.
Protective device clearing time.
Duration of arc.
Arc-flash boundary.
Restricted approach boundary.
Limited approach boundary.
Working distance.
Incident energy.
Hazard risk category.
Recommendations for arc-flash energy reduction.

Comments and recommendations for system improvements or revisions in a written document, separate from one-line diagram.

Retain the following article if an arc-flash study is included.

2.2 ARC-FLASH WARNING LABELS

Comply with requirements in Section 26 05 53 "Identification for Electrical Systems" for self-adhesive equipment labels. Produce a 3.5-by-5-inch self-adhesive equipment label for each work location included in the analysis.

Label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:

Location designation.
Nominal voltage.
Protection boundaries.

Arc-flash boundary.
Restricted approach boundary.
Limited approach boundary.

Arc flash PPE category.
Required minimum arc rating of PPE in Cal/cm squared.
Available incident energy.
Working distance.
Engineering report number, revision number, and issue date.

Labels shall be machine printed, with no field-applied markings.

PART 3 - EXECUTION

3.0 POWER SYSTEM DATA

Obtain all data necessary to conduct the study.

Verify completeness of data supplied on one-line diagram. Call any discrepancies to Architect's attention.
For equipment included as Work of this Project, use characteristics submitted under provisions of action submittals and information submittals for this Project.

3.1 FAULT CURRENT STUDY

Perform study following the general study procedures contained in IEEE 399.

Calculate fault currents according to IEEE 551.

Base study on device characteristics supplied by device manufacturer.

Extent of electrical power system to be studied is indicated on Drawings.

Begin fault current analysis at the service, extending down to system overcurrent protective devices as follows:

To normal system low-voltage load buses where fault current is 10 kA or less.
Exclude equipment rated 240 V ac or less when supplied by a single transformer rated less than 125 kVA.
<Insert description>.

Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.

Include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and apply to low- and medium-voltage, three-phase ac systems. Also account for the fault-current dc decrement to address asymmetrical requirements of interrupting equipment.

Calculate fault current momentary and interrupting duties for a three-phase bolted fault and a single line-to-ground fault at each equipment indicated on one-line diagram.

For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault study.

Include in the report identification of any protective device applied outside its capacity.

3.2 COORDINATION STUDY

Comply with IEEE 242 for calculating fault currents and determining coordination time intervals.

Transformer Primary Overcurrent Protective Devices:

Device shall not operate in response to the following:

Inrush current when first energized.
Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.

Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.

Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.

Motor Protection:

Select protection for low-voltage motors according to IEEE 242 and NFPA 70.
Select protection for motors served at voltages more than 600 V according to IEEE 620.

Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and protection recommendations in IEEE 242. Demonstrate that equipment withstands the maximum fault current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and fault current.

Generator Protection: Select protection according to manufacturer's written instructions and to IEEE 242.

Include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and apply to low- and medium-voltage, three-phase ac systems. Also account for fault-current dc decrement, to address asymmetrical requirements of interrupting equipment.

Calculate fault current momentary and interrupting duties for a three-phase bolted fault and a single line-to-ground fault at each equipment indicated on one-line diagram.

For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault study.

Protective Device Evaluation:

Evaluate equipment and protective devices and compare to short-circuit ratings.
Adequacy of switchgear, motor-control centers, and panelboard bus bars to withstand short-circuit stresses.
Any application of series-rated devices shall be recertified, complying with requirements in NFPA 70.
Include in the report identification of any protective device applied outside its capacity.

3.3 LOAD-FLOW AND VOLTAGE-DROP STUDY

Perform a load-flow and voltage-drop study to determine the steady-state loading profile of the system. Analyze power system performance two times as follows:

Determine load flow and voltage drop based on full-load currents obtained in "Power System Data" Article.
Determine load flow and voltage drop based on 80 percent of the design capacity of load buses.
Prepare load-flow and voltage-drop analysis and report to show power system components that are overloaded or might become overloaded; show bus voltages that are less than as prescribed by NFPA 70.

3.4 MOTOR-STARTING STUDY

Perform a motor-starting study to analyze the transient effect of system's voltage profile during motor starting. Calculate significant motor-starting voltage profiles and analyze the effects of motor starting on the power system stability.

Prepare the motor-starting study report, noting light flicker for limits proposed by IEEE 141, and voltage sags so as not to affect operation of other utilization equipment on system supplying the motor.

3.5 FIELD ADJUSTING

Adjust relay and protective device settings according to recommended settings provided by the coordination study. Field adjustments shall be completed by the engineering service division of equipment manufacturer under the "Startup and Acceptance Testing" contract portion.

Make minor modifications to equipment as required to accomplish compliance with fault current and protective device coordination studies.

Testing and adjusting shall be by a full-time employee of the Field Adjusting Agency, who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification.

Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters. Perform NETA tests and inspections for all adjustable overcurrent protective devices.

3.6 ARC-FLASH HAZARD STUDY

Comply with NFPA 70E and its Annex D for hazard analysis study.

Preparatory Studies: Perform the Fault Current and Protective Device Coordination studies prior to starting the Arc-Flash Hazard Analysis.

Calculate maximum and minimum contributions of fault-current size.

Maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.
Calculate arc-flash energy at 85 percent of maximum fault current according to IEEE 1584 recommendations.
Calculate arc-flash energy at 38 percent of maximum fault current according to NFPA 70E recommendations.
Calculate arc-flash energy with the utility contribution at a minimum and assume no motor contribution.

Calculate the arc-flash protection boundary and incident energy at locations in electrical distribution system where personnel could perform work on energized parts.

Include medium- and low-voltage equipment locations, except equipment rated 240 V ac or less fed from transformers less than 125 kVA.

Calculate the limited, restricted, and prohibited approach boundaries for each location.

Incident energy calculations shall consider the accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations shall consider the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators shall be decremented as follows:

Fault contribution from induction motors shall not be considered beyond three to five cycles.
Fault contribution from synchronous motors and generators shall be decayed to match the actual decrement of each as closely as possible (for example, contributions from permanent magnet generators will typically decay from 10 per unit to three per unit after 10 cycles).

Arc-flash energy shall generally be reported for the maximum of line or load side of a circuit breaker. However, arc-flash computation shall be performed and reported for both line and load side of a circuit breaker as follows:

When the circuit breaker is in a separate enclosure.
When the line terminals of the circuit breaker are separate from the work location.

Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at two seconds based on IEEE 1584, Section B.1.2.

3.7 LABELING

Apply one arc-flash label on the front cover of each section of the equipment and on side or rear covers with accessible live parts and hinged doors or removable plates for each equipment included in the study. Base arc-flash label data on highest values calculated at each location.

Each piece of equipment listed below shall have an arc-flash label applied to it:

Low-voltage switchboard.
Low voltage transformers.
Panelboard and safety switch over 250 V.
Applicable panelboard and safety switch under 250 V.
Control panel.

Note on record Drawings the location of equipment where the personnel could be exposed to arc-flash hazard during their work.

Indicate arc-flash energy.
Indicate protection level required.

3.8 APPLICATION OF WARNING LABELS

Install arc-flash warning labels under the direct supervision and control of Power System Analysis Specialist.

3.9 DEMONSTRATION

Engage Power Systems Analysis Specialist to train Owner's maintenance personnel in the following:

Acquaint personnel in fundamentals of operating the power system in normal and emergency modes.
Hand-out and explain the coordination study objectives, study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpreting time-current coordination curves.

Engage Power Systems Analysis Specialist to train Owner's maintenance personnel in potential arc-flash hazards associated with working on energized equipment and the significance of arc-flash warning labels.

END OF SECTION 26 05 73.13

SECTION 26 09 23
LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.0 SUMMARY

This Section includes the following lighting control devices:

- Timer controls.
- Outdoor photoelectric switches.
- Daylight-harvesting switching controls.
- Daylight-harvesting dimming controls.
- Indoor occupancy and vacancy sensors.
- Switchbox-mounted occupancy and vacancy sensors.
- Digital timer light switch.
- Low voltage switches
- Lighting contactors.
- Emergency shunt relays.

1.1 DEFINITIONS

BAS: Building Automation System.

LED: Light-emitting diode.

PIR: Passive infrared.

1.2 SUBMITTALS

Specification of lighting control devices may be indicated on the Drawings, within this Specifications Section, or a combination of both. In either case, Submittals shall be prepared based on the requirements below.

Product Data: For each type of product indicated.

Shop Drawings:

- Installation details and wiring diagrams.
- Riser diagrams for network control systems.
- Sequence of control narrative, notes, or matrix.
- Layout Drawings: including the following:
  - System notes.
  - Legend for control device and wiring products.
  - Scaled reflected ceiling plan(s) showing luminaires and associated control devices locations including zone notation between luminaires and control devices.
  - Wiring connections between control devices.

1.3 SUBSTITUTIONS AND ALTERNATES

Substitutions and alternates for lighting control devices shall be in accordance with Division 1 and Division 26 Section "Basic Electrical Requirements."

1.4 BIDDING

Manufacturers of lighting controls specified shall be assumed capable of supplying the lighting control products, including all accessories, unless exceptions are set forth in their quotations. Any such exceptions shall immediately be brought to the attention of the Architect and Engineer for resolution. Such resolution may involve changing the specification of one or more lighting control products and time shall be afforded for this process.

1.5 QUALITY ASSURANCE

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.

Individual components or assembly of components into control system shall accommodate the square-footage coverage requirements for each area controlled, utilizing room controllers, digital occupancy sensors, switches, daylighting sensors and accessories that suit the required lighting and electrical system parameters.

Manufacturer Qualifications: Company specializing in manufacturing of centralized and distributed lighting control systems with a minimum of 10 years documented experience.

Installer Qualifications: Company certified by the manufacturer and specializing in installation of lighting control products with minimum three years documented experience.

System Components: Demonstrate that individual components have undergone quality control and testing prior to shipping.

1.6 COORDINATION

Coordinate layout and installation of ceiling-and wall mounted devices with other trades as required for preparation of Coordination Drawings.

Coordinate the work to provide controls compatible with the lighting to be installed.

1.7 WARRANTY

Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace lighting control devices that fail(s) in materials or workmanship within specified warranty period.

Failures include, but are not limited to, the following:

Faulty operation of lighting control devices.

Warranty Period: Two year(s) from date of Substantial Completion.

1.8 EXTRA MATERIALS

Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. A typewritten list, including quantities, of all extra materials provided shall be included in the operations and maintenance manual.

Daylight Harvesting Switch Controls: 1 for every 20 of each type and rating installed. Furnish at least one of each type.
Daylight Harvesting Dimming Controls: 1 for every 20 of each type and rating installed. Furnish at least one of each type.

Indoor Occupancy Sensors: 1 for every 20 of each type and rating installed. Furnish at least one of each type.
Indoor Vacancy Sensors: 1 for every 20 of each type and rating installed. Furnish at least one of each type.
Switchbox Mounted Occupancy Sensors: 1 for every 20 of each type and rating installed. Furnish at least one of each type.
Switchbox Mounted Vacancy Sensors: 1 for every 20 of each type and rating installed. Furnish at least one of each type.
Low Voltage Switches: 1 for every 20 of each type and rating installed. Furnish at least one of each type.
Power Packs: 1 for every 20 of each type and rating installed. Furnish at least one of each type.

PART 2 - PRODUCTS

2.0 TIMER CONTROLS

Manufacturers: Subject to compliance with requirements, provide basis of design product indicated on Drawings or a comparable product by one of the following:

Intermatic, Inc.
NSI Industries (TORK).

Digital/Electronic Controls: Astronomic 365/7-Day, solid-state programmable type with alphanumeric display; complying with UL 917.

Contact Configuration: SPST or DPST
Contact Rating: 20-A ballast load, 120/240-V ac.
Program: 8 on-off set points on a 24-hour schedule and an annual holiday schedule that overrides the weekly operation on holidays.
Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program on selected channels.
Astronomic Time: All channels.
Automatic daylight savings time changeover.
Battery Backup: Not less than seven days reserve, to maintain schedules and time clock.

Electromechanical Time Switches: Astronomic 24-hour dial type; complying with UL 917.

Contact Configuration: SPST or DPST
Contact Rating: 20-A ballast load, 120/240-V ac.
Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program.
Eight-Day Program: Uniquely programmable for each weekday and holidays.
Skip-a-day mode.
Wound-spring reserve carryover mechanism to keep time during power failures, minimum of 16 hours.

2.1 PHOTOELECTRIC SWITCHES FOR EXTERIOR LIGHTING

Manufacturers: Subject to compliance with requirements, provide basis of design product [indicated on Drawings or a comparable product by one of the following:

Intermatic, Inc.
NSI Industries (TORK).

Description: Solid state, with SPST or DPST dry contacts rated for 1800-VA tungsten or 1000-VA inductive, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.

Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range**,** and a directional lens in front of photocell to prevent fixed light sources from causing turn-off.
Time Delay: 15-second minimum, to prevent false operation.
Surge Protection: Metal-oxide varistor, complying with IEEE C62.41.1, IEEE C62.41.2, and IEEE 62.45 for Category A1 locations.
Mounting: Twist lock complying with IEEE C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.

2.2 DAYLIGHT HARVESTING SWITCHING CONTROLS FOR INTERIOR LIGHTING

Manufacturers: Subject to compliance with requirements, provide the basis of design product indicated on Drawings or a comparable product by one of the following:

Cooper Industries, Inc.
Hubbell Control Solutions
Leviton Manufacturing, Inc.
Lithonia Lighting; Acuity Lighting Group, Inc.
Watt Stopper (The).
Osram Encelium.

Description: Sensing daylight and electrical lighting levels, the system switches off the indoor electrical lighting at a predefined level as the daylight increases. Unless otherwise noted, the predefined level shall be 200% of the electrical lighting without daylighting contribution.

System Programming: Hand-held remote-control tools.

Ceiling-Mounted Switching Controls: Solid-state, light-level sensor unit, with integrated power pack, that detects changes in indoor lighting levels.

Electrical Components, Devices, and Accessories:

Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.
Sensor Output: Contacts rated to operate the associated power pack, complying with UL 773A. Sensor shall be powered by the power pack.
Sensor Output: Digital signal compatible with power pack.
Sensor type: Open loop or Closed loop.
Zone: Single or Multi.
Power Pack: Dry contacts rated for 20-A LED load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 HP at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.

LED status lights to indicate load status.
Plenum rated.

Power Pack: Digital controller capable of accepting up to four (4) RJ45 inputs with two outputs rated for 16-A LED at 120- and 277-V ac, and for 1 HP at 120-V ac. Sensor has 24-V dc Class 2 power source, as defined by NFPA 70.

With integral current monitoring
Compatible with digital addressable lighting interface.

Plenum rated.

General Space Sensors Light-Level Monitoring Range: 10 to 200 fc, with an adjustment for turn-on and turn-off levels within that range.
Atrium Space Sensors Light-Level Monitoring Range: 100 to 1000 fc, with an adjustment for turn-on and turn-off levels within that range.
Skylight Sensors Light-Level Monitoring Range: 1000 to 10,000 fc, with an adjustment for turn-on and turn-off levels within that range.
Time Delay: Adjustable from 5 to 300 seconds to prevent cycling.
Set-Point Adjustment: Equip with deadband adjustment of 25, 50, and 75 percent above the "on" set point, or provide with separate adjustable "on" and "off" set points.
Test Mode: User selectable, overriding programmed time delay to allow settings check.
Control Load Status: User selectable to confirm that load wiring is correct.
Indicator: Two digital displays to indicate the beginning of on-off cycles.

2.3 DAYLIGHT-HARVESTING DIMMING CONTROLS FOR INTERIOR LIGHTING

Manufacturers: Subject to compliance with requirements, provide the basis of design product indicated on Drawings or a comparable product by one of the following:

Cooper Industries, Inc.
Hubbell Control Solutions
Leviton Manufacturing, Inc.
Lithonia Lighting; Acuity Lighting Group, Inc.
Watt Stopper (The).
Osram Encelium.

Description: Sensing daylight and electrical lighting levels, the system dims the indoor electrical lighting levels to a predefined level as the daylight increases. Unless otherwise noted, the predefined level shall be 100% of the electrical lighting without daylight contribution.

System Programming: Hand-held remote control tools.

Ceiling-Mounted Dimming Controls: Solid-state, light-level sensor unit, with integrated power pack, that detects changes in indoor lighting levels.

Electrical Components, Devices, and Accessories:

Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.
Sensor Output: 0- to 10-V dc to operate luminaires. Sensor is powered by controller unit.
Light-Level Sensor Set-Point Adjustment Range: 2 to 200 fc.

Power Pack: Dry contacts rated for 20-A LED load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 HP at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.

LED status lights to indicate load status.
Plenum rated.

Power Pack: Digital controller capable of accepting up to four (4) RJ45 inputs with two outputs rated for 16-A LED at 120- and 277-V ac, and for 1 HP at 120-V ac. Sensor has 24-V dc Class 2 power source, as defined by NFPA 70.

With integral current monitoring
Compatible with digital addressable lighting interface.
Plenum rated.

2.4 INDOOR OCCUPANCY AND VACANCY SENSORS

Manufacturers: Subject to compliance with requirements, provide the basis of design product indicated on Drawings or a comparable product by one of the following:

Cooper Industries, Inc.
Hubbell Lighting.
Leviton Mfg. Company Inc.
Lithonia Lighting; Acuity Lighting Group, Inc.
Watt Stopper (The).

General Requirements for Sensors:

Wall- and Ceiling-mounted, solid-state indoor occupancy and vacancy sensors.
Passive infrared, Ultrasonic, and Dual-technology.
Integrated and Separate power pack.
Hardwired and Wireless connection to switch and BAS
Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
Operation:

Occupancy Sensor: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
Vacancy Sensor: Unless otherwise indicated, lights are manually turned on and sensor turns lights off when the room is unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
Combination Sensor: Unless otherwise indicated, sensor shall be programmed to turn lights on when coverage area is occupied and turn them off when unoccupied, or to turn off lights that have been manually turned on; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.

Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A
Sensor is powered from the power pack.
Power: Line voltage or Low voltage
Power Pack: Dry contacts rated for 20-A LED load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 HP at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
Mounting:

Sensor: Suitable for mounting in any position on a standard outlet box.
Relay: Externally mounted through a 1/2-inch (13-mm) knockout in a standard electrical enclosure.
Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
Bypass Switch: Override the "on" function in case of sensor failure.
Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (21.5 to 2152 lux); turn lights off when selected lighting level is present.

PIR Type: Wall or Ceiling mounted; detect occupants in coverage area by their heat and movement.

Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm).
Detection Coverage (Room, Ceiling Mounted): Detect occupancy anywhere in a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
Detection Coverage (Corridor, Ceiling Mounted): Detect occupancy within 90 feet (27.4 m) when mounted on a 10-foot- (3-m-) high ceiling.
Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of up to 3000 square feet (330 square meters) when mounted 48 inches (1200 mm) above finished floor.

Ultrasonic Type: Wall or Ceiling mounted; detect occupants in coverage area through pattern changes of reflected ultrasonic energy.

Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of 600 sq. ft. (56 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
Detection Coverage (Large Room): Detect occupancy anywhere within a circular area of 2000 sq. ft. (186 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
Detection Coverage (Corridor): Detect occupancy anywhere within 90 feet (27.4 m) when mounted on a 10-foot- (3-m-) high ceiling in a corridor not wider than 14 feet (4.3 m).
Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of 1000 square feet (110 square meters) minimum and up to 3000 square feet (330 square meters) when mounted 84 inches (2100 mm) above finished floor.

Dual-Technology Type: Wall or Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.

Sensitivity Adjustment: Separate for each sensing technology.
Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm), and detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of 1000 square feet (110 square meters) minimum and up to 3000 square feet (330 square meters) when mounted 48 inches (1200 mm) above finished floor.

2.5 SWITCHBOX-MOUNTED OCCUPANCY AND VACANCY SENSORS

Basis-of-Design Product: Subject to compliance with requirements, provide the basis of design product indicated on Drawings or a comparable product by one of the following:

Cooper Industries, Inc.
Crestron
Hubbell Lighting.
Leviton Mfg. Company Inc.

Lithonia Lighting; Acuity Lighting Group, Inc.
Watt Stopper (The).
Osram Encelium

General Requirements for Sensors: Automatic-wall-switch occupancy sensor with manual on-off switch, suitable for mounting in a single gang switchbox using hardwired or wireless connection.

Vacancy Sensor Operation: Unless otherwise indicated, manual “on” and sensors maintains lights on when coverage area is occupied, and automatically turn lights off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.
Switch Rating: Not less than 800-VA LED load at 120 V, 1200-VA LED load at 277 V, and 800-W incandescent.

Adjustable Range Sensor:

Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of 900 sq. ft.
Sensing Technology: PIR or Dual technology - PIR and ultrasonic.
Switch Type: Field-selectable automatic "on," or manual "on," with automatic "off." Capable of controlling load in three-way application.
Voltage: Dual voltage - 120 and 277 V.
Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc. The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
Concealed, "off" time-delay selector at 30 seconds and 5, 10, and 20 minutes.
Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.
Color: As indicated on the Lighting Controls Schedule
Faceplate: Color matched to switch.

Fix Range Sensor:

Standard Range: 210-degree (minimum) field of view, with a minimum coverage area of 900 sq. ft.
Sensing Technology: PIR.
Switch Type: Field-selectable automatic "on," or manual "on," with automatic "off." Capable of controlling load in three-way application.
Voltage: Dual voltage, 120 and 277 V.
Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc. The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
Concealed, "off" time-delay selector at 30 seconds and 5, 10, and 20 minutes.
Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.
Color: Comply with Division 26 Section “Wiring Devices.”
Faceplate: Single and multigang-plates as specified in Division 26 Section “Wiring Devices.”

2.6 DIGITAL TIMER LIGHT SWITCH

Manufacturers: Subject to compliance with requirements, provide products by one of the following:

Basis-of-Design Product: Subject to compliance with requirements, provide the basis of design product indicted on Drawings or a comparable product by one of the following:

Cooper Industries, Inc.
Crestron
Hubbell Lighting.
Leviton Mfg. Company Inc.
Lithonia Lighting; Acuity Lighting Group, Inc.
Watt Stopper (The).
Osram Encelium
NSI Industries (TORK).
Watt Stopper (The).

Description: Combination digital timer and conventional switch lighting control unit. Switchbox-mounted, backlit LCD display, with selectable time interval in 10 minute increments.

Rated 960 W at 120-V ac for tungsten lighting, 10 A at 120-V ac or 10 amps at 277-V ac for LED, and 1/4 horsepower at 120-V ac.
Integral relay for connection to BAS.
Voltage: Dual voltage - 120 and 277 V.
Color: As indicated on the Lighting Controls Schedule.
Faceplate: Color matched to switch.

2.7 LOW VOLTAGE SWITCHES

Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

Cooper Industries, Inc.
Crestron
Hubbell Lighting.
Leviton Mfg. Company Inc.
Lithonia Lighting; Acuity Lighting Group, Inc.
Watt Stopper (The).
Osram Encelium

Momentary pushbutton switches in 1, 2, 3, 4, 5 and 8 button configurations. Wall switches shall include the following features:

Field programmable.
Removable buttons for field replacement with engraved buttons and/or alternate color buttons. Button replacement may be completed without removing the switch from the wall.
Configuration LED on each switch that blinks to indicate data transmission.
Load/Scene Status LED on each switch button with the following characteristics:

Bi-level LED
Dim locator level indicates power to switch
Bright status level indicates that load or scene is active
Dimming switches shall include seven bi-level LEDs to indicate load levels using 14 steps.

Programmable control functionality including:

Button priority may be configured to any BACnet priority level, from 1-16, corresponding to networked operation allowing local actions to utilize life safety priority

Scene patterns may be saved to any button other than dimming rockers. Once set, buttons may be digitally locked to prevent overwriting of the preset levels.

All digital parameter data programmed into an individual wall switch shall be retained in non-volatile FLASH memory within the wall switch itself. Memory shall have an expected life of no less than 10 years.

BACnet object information shall be available for the following objects:

Button state
Switch lock control
Switch lock status

Two RJ-45 ports for connection to local control network.

Multiple digital wall switches may be installed in a room by simply connecting them to the free topology local control network. No additional configuration shall be required to achieve multi-way switching.

Load and Scene button function may be reconfigured for individual buttons from Load to Scene, and vice versa.

Individual button function may be configured to Toggle, On only or Off only.
Individual scenes may be locked to prevent unauthorized change.
Fade Up and Fade Down times for individual scenes may be adjusted from 0 seconds to 18 hours.
Ramp rate may be adjusted for each dimmer switch.
Color: Comply with Division 26 Section “Wiring Devices.”
Wall Plates: Single and multigang-plates as specified in Division 26 Section “Wiring Devices.”

2.8 HIGH-BAY OCCUPANCY SENSORS

Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

Cooper Industries, Inc.
Crestron
Hubbell Lighting.
Leviton Mfg. Company Inc.
Lithonia Lighting; Acuity Lighting Group, Inc.
Watt Stopper (The).
Osram Encelium

Description: Solid-state unit. The unit is designed to operate with the lamp and ballasts indicated.

Operation: Turn lights on when coverage area is occupied, and to half-power when unoccupied; with a time delay for turning lights to half-power that is adjustable over a minimum range of 1 to 16 minutes.
Continuous Lamp Monitoring: When lamps are dimmed continuously for 24 hours, automatically turn lamps on to full power for 15 minutes for every 24 hours of continuous dimming.
Power: Line voltage.
Operating Ambient Conditions: 32 to 149 deg F.
Mounting: Threaded pipe.
Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
Detector Technology: PIR.

Power and dimming control from the luminaire ballast that has been modified to include the dimming capacitor and MyzerPORT option.

Detector Coverage: User selectable by interchangeable PIR lenses, suitable for mounting heights from 12 to 50 feet.

Accessories: Obtain manufacturer's installation and maintenance kit with laser alignment tool for sensor positioning and power port connectors.

2.9 EXTREME-TEMPERATURE OCCUPANCY SENSORS

Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

Cooper Industries, Inc.
Crestron
Hubbell Lighting.
Leviton Mfg. Company Inc.
Lithonia Lighting; Acuity Lighting Group, Inc.
Watt Stopper (The).
Osram Encelium

Description: Ceiling-mounted, solid-state, extreme-temperature occupancy sensors with a separate power pack.

Operation: Turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 30 minutes.
Operating Ambient Conditions: From minus 40 to plus 125 deg F.
Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor is powered from the power pack.
Power Pack: Dry contacts rated for 20-A LED load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 HP at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
Mounting:

Sensor: Suitable for mounting in any position on a standard outlet box.
Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
Time-Delay and Sensitivity Adjustments: Recessed and concealed behind cover.

Bypass Switch: Override the "on" function in case of sensor failure.
Automatic Light-Level Sensor: Adjustable from 2 to 10 fc; keep lighting off when selected lighting level is present.

Detector Technology: PIR. Ceiling mounted; detect occupants in coverage area by their heat and movement.

Detector Sensitivity: Detect occurrences of 6-inchminimum movement of any portion of a human body that presents a target of not less than 36 sq. in.
Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1500 sq. ft. when mounted on a 96-inch high ceiling.
Detection Coverage (High Bay): Detect occupancy within 25 feet when mounted on a 25-foot high ceiling.

2.10 OUTDOOR MOTION SENSORS (PIR)

Manufacturers: Subject to compliance with requirements, provide products by one of the following:

Manufacturers: Subject to compliance with requirements, provide the basis of design product indicated on Drawings] or a comparable product by one of the following:

Cooper Industries, Inc.
Hubbell Lighting.
Leviton Mfg. Company Inc.
Lithonia Lighting; Acuity Lighting Group, Inc.
Watt Stopper (The).
<Insert manufacturer's name.>

Manufacturers: Subject to compliance with requirements, provide product indicated on lighting control schedule on Drawings. [Manufacturer listed first, or a single manufacturer listed, for a control type on schedule shall be considered as the basis of design product. Contractor is responsible for provision of product and performance equal to basis of design for other manufacturers listed without part number for each control type.] [Alternate controls shall be submitted for [one][two][three][all] of the following local manufacturer’s representative companies for control types that have one basis of design manufacturer listed on schedule:

Illumination Systems Incorporated.
Lighting Agency, The
MH Lighting]

Description: Solid-state outdoor motion sensors.

PIR or Dual-technology (PIR and ultrasonic) type, weatherproof. Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm). Comply with UL 773A.
Switch Rating:

Luminaire-Mounted Sensor: 500-VA fluorescent/LED.
Separately Mounted Sensor: Dry contacts rated for 20-A LED load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 HP at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.

Switch Type: SP.
Voltage: Dual voltage, 120- and 277-V type.
Detector Coverage:

Standard Range: 210-degree field of view, with a minimum coverage area of 900 sq. ft. (84 sq. m).
Long Range: 180-degree field of view and 110-foot (34-m) detection range.

Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc (108 to 1600 lux). The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
Concealed, "off" time-delay selector at 30 seconds and 5, 10, and 20 minutes.
Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and help eliminate false "off" switching.
Operating Ambient Conditions: Suitable for operation in ambient temperatures ranging from minus 40 to plus 130 deg F (minus 40 to plus 54 deg C), rated as "raintight" according to UL 773A.

2.11 LIGHTING CONTACTORS

Manufacturers: Subject to compliance with requirements, provide products by one of the following:

Manufacturers: Subject to compliance with requirements, provide the basis of design product indicated on Drawings or a comparable product by one of the following:

ASCO Power Technologies, LP; a division of Emerson Electric Co.
Eaton Electrical Inc.; Cutler-Hammer Products.
GE Industrial Systems; Total Lighting Control.
Siemens Energy & Automation, Inc.
Square D; Schneider Electric.

Description: Electrically operated and [**mechanically**] [**electrically**] held, combination type with [**fusible switch**] [**nonfused disconnect**], complying with NEMA ICS 2 and UL 508.

Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).
Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
Enclosure: Comply with NEMA 250.
Provide with control and pilot devices as indicated on Drawings, matching the NEMA type specified for the enclosure.

Interface with BAS System for HVAC: Provide hardware interface to enable the BAS for HVAC to monitor and control lighting contactors.

Monitoring: On-off status
Control: On-off operation

2.12 EMERGENCY SHUNT RELAY

Manufacturers: Subject to compliance with requirements, provide products by one of the following:

Manufacturers: Subject to compliance with requirements, provide the basis of design product indicated on Drawings or a comparable product by one of the following:

Cooper Industries, Inc.
Hubbell Lighting.
Leviton Mfg. Company Inc.
Lithonia Lighting; Acuity Lighting Group, Inc.
Watt Stopper (The).

Description: Normally closed, electrically held relay, arranged for wiring in parallel with manual or automatic switching contacts; complying with UL 924.
Coil Rating: 120 or 277 V.

2.13 CONDUCTORS AND CABLES

Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Division 26 Section "Building Wire and Cable."

Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 24 AWG. Comply with requirements in Division 26 Section "Building Wire and Cable."

Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Division 26 Section "Building Wire and Cable."

CAT-5e or similar low voltage communication cable (per division 27 requirements) shall be yellow and black striped to avoid confusion with other building communication and data systems. Such cable shall be manufacturer furnished and tested with pre-terminated RJ-454 connectors.

PART 3 - EXECUTION

3.0 EXAMINATION

Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.

Examine walls and ceilings for suitable conditions where lighting control devices will be installed.

Proceed with installation only after unsatisfactory conditions have been corrected.

3.1 SENSOR INSTALLATION

Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.2 CONTACTOR INSTALLATION

Mount electrically held lighting contactors with elastomeric isolator pads, to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.3 WIRING INSTALLATION

Comply with NECA 1.

Wiring Method: Install wiring in raceways except where installed in accessible ceilings. Comply with Division 26 Section "Building Wire and Cable." Minimum conduit size shall be 1/2 inch (13 mm).

Wiring within Enclosures: Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.4 IDENTIFICATION

Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."

Identify controlled circuits in lighting contactors.
Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.

Label time switches and contactors with a unique designation.

3.5 FIELD QUALITY CONTROL

Testing Agency: Engag a qualified testing agency to evaluate lighting control devices and perform tests and inspections.

Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

Perform the following tests and inspections[with the assistance of a factory-authorized service representative]:

Verify Class 1 and 2 wiring connections are terminated properly.
Verify programming of components.
Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized and programmed, start units to confirm proper sequence of operation for each space.
Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment and retest.

Lighting control devices will be considered defective if they do not pass tests and inspections.

Prepare test and inspection reports in table format with drawings including each room or space that has lighting control installed. Indicate the following:

Date of test or inspection.
Quantity and Type of each device installed.
Reports providing each device's settings.

3.6 ADJUSTING

Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting lighting control devices to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

For occupancy and vacancy sensors, verify operation at outer limits of detector range.
Set time delay to suit Owner's operations.
For daylighting controls, adjust set points and deadband controls to suit Owner's operations.
Align high-bay occupancy sensors using manufacturer's aiming tool.

3.7 DEMONSTRATION

Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control system specified in Division 26 Section "Network Lighting Controls."

Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 26 09 23

SECTION 26 09 43

NETWORK LIGHTING CONTROLS

PART 1 - GENERAL

1.0 SUMMARY

This Section includes manually operated, PC-based, digital lighting controls with external signal source, relays, electrically operated circuit breakers, and control module.

Related Sections include the following:

Division 26 Section "Lighting Control Devices" for time switches, photoelectric switches, occupancy sensors, and multipole contactors.

1.1 DEFINITIONS

BACnet: A networking communication protocol that complies with ASHRAE 135.

BAS: Building automation system.

DALI: Digital addressable lighting interface.

LonWorks: A control network technology platform for designing and implementing interoperable control devices and networks.

Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling and power-limited circuits.

Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.

PC: Personal computer; sometimes plural as "PCs."

Power Line Carrier: Use of radio-frequency energy to transmit information over transmission lines whose primary purpose is the transmission of power.

RS-485: A serial network protocol, similar to RS-232, complying with TIA/EIA-485-A.

1.2 SUBMITTALS

Specification of lighting control devices may be indicated on the Drawings, within this Specifications Section, or a combination of both. In either case, Submittals shall be prepared based on the requirements below.

Product Data: For control modules, power distribution components, manual switches and plates, and conductors and cables.

Shop Drawings: Detail assemblies of standard components, custom assembled for specific application on this Project.

Outline Drawings: Indicate dimensions, weights, arrangement of components, and clearance and access requirements.

Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.
Wiring Diagrams: Power, signal, and control wiring. Coordinate nomenclature and presentation with a block diagram.

Coordination Drawings: Submit evidence that lighting controls are compatible with connected monitoring and control devices and systems specified in other Sections.

Show interconnecting signal and control wiring and interfacing devices that prove compatibility of inputs and outputs.
For networked controls, list network protocols and provide statements from manufacturers that input and output devices meet interoperability requirements of the network protocol.

Software and Firmware Operational Documentation:

Software operating and upgrade manuals.
Program Software Backup: On a magnetic media or compact disc, complete with data files.
Device address list.
Printout of software application and graphic screens.

[Field quality-control test reports.]

Software licenses and upgrades required by and installed for operation and programming of digital and analog devices.

1.3 SUBSTITUTIONS AND ALTERNATES

Substitutions and alternates for lighting control devices shall be in accordance with Division 1 and Division 26 Section "Basic Electrical Requirements."

1.4 BIDDING

Manufacturers of lighting controls specified shall be assumed capable of supplying the lighting control products, including all accessories, unless exceptions are set forth in their quotations. Any such exceptions shall immediately be brought to the attention of the Architect and Engineer for resolution. Such resolution may involve changing the specification of one or more lighting control products and time shall be afforded for this process.

1.5 QUALITY ASSURANCE

Source Limitations: Obtain lighting control module and power distribution components through one source from a single manufacturer.

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.

Manufacturer Qualifications: Company specializing in manufacturing of centralized and distributed lighting control systems with a minimum of 10 years documented experience.

Installer Qualifications: Company certified by the manufacturer and specializing in installation of lighting control products with minimum three years documented experience.

System Components: Demonstrate that individual components have undergone quality control and testing prior to shipping.

Comply with 47 CFR, Subparts A and B, for Class A digital devices.

Comply with protocol described in IEC 60929, Annex E, for DALI lighting control devices, wiring, and computer hardware and software.

Comply with NFPA 70.

1.6 COORDINATION

Coordinate lighting control components to form an integrated interconnection of compatible components.

Match components and interconnections for optimum performance of lighting control functions.
Coordinate lighting controls with BAS. Design display graphics showing building areas controlled; include the status of lighting controls in each area.
Coordinate lighting controls with that in Sections specifying distribution components that are monitored or controlled by power monitoring and control equipment.

Coordinate lighting control components specified in this Section with components specified in Division 26 Section "Panelboards."

1.7 WARRANTY

Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of lighting controls that fail in materials or workmanship or from transient voltage surges within specified warranty period.

Failures include, but are not limited to, the following:

Failure of software input/output to execute switching or dimming commands.
Failure of modular relays to operate under manual or software commands.
Damage of electronic components due to transient voltage surges.

Warranty Period: Two years from date of Substantial Completion.
Extended Warranty Period Failure Due to Transient Voltage Surges: Eight years.
Extended Warranty Period for Electrically Held Relays: 10 years from date of Substantial Completion.

1.8 EXTRA MATERIALS

Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

Electrically Held Relays: Equal to 10 percent of amount installed for each size indicated, but no fewer than one (1) relay(s).
Electrically Operated, Molded-Case Circuit Breakers: Equal to 10 percent of amount installed for each size indicated, but no fewer than one (1) circuit breaker(s).

1.9 SOFTWARE SERVICE AGREEMENT

Technical Support: Beginning with Substantial Completion, provide software support for two years.

Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revise licenses for use of the software.

Provide 30-day notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment, if necessary.

PART 2 - PRODUCTS

2.0 MANUFACTURERS

Manufacturers: Subject to compliance with requirements, provide the basis of design product indicated on Drawings or a comparable product by one of the following:

Crestron
Intelligent Lighting Controls, Inc.
Leviton Mfg. Company Inc.
Lighting Control & Design, Inc.
Lithonia Lighting; Acuity Lighting Group, Inc.
Lutron Electronics Company, Inc.
NexLight; Northport Engineering Group.
Osram Encelium.
Square D; Schneider Electric.
Starfield Lighting Automation
Touch-Plate, Inc.
TRIATEK, Inc.
Watt Stopper (The).

2.1 SYSTEM REQUIREMENTS

Expandability: System shall be capable of increasing the number of control functions in the future by 25 percent of current capacity; to include equipment ratings, housing capacities, spare relays, terminals, number of conductors in control cables, and control software.

Performance Requirements: Manual switches, an internal timing and control unit, and external sensors or other control signal sources send a signal to a PC-based programmable-system control module that processes the signal according to its programming and routes an open or close command to one or more [**relays**] [**electrically operated circuit breakers**] in the power-supply circuits, or routes variable commands to one or more dimmers, for groups of luminaires or other loads.

2.2 CONTROL MODULE

Control Module Description: Programmable, PC-based unit with [**17-inch color video monitor**] [**15-inch color LCD**] and keyboard for graphic display and programming of system status and to override breaker status; and to display status of local override controls and diagnostic information. If the control module is applied to emergency lighting units, control unit shall indicate failure of normal power and that the lighting units are, or are not, powered by the alternate power source.

Display: Single graphic display for programming lighting control panelboards.
Display: Separate graphic displays for programming each lighting control panelboard.
Interoperability: Control module shall be configured to connect with other control systems using RS-485 network to enable remote workstations to use control module functions.
Interoperability: Control module shall be configured to connect to LonWorks or BACnet - compliant network, resulting in extending control to any network-compliant devices such as occupancy switches.

Interoperability: Lighting control shall be configured to allow individual users to turn lighting on and off with their PCs. Software shall be written for Windows operating system, with Web page as the display and ActiveX controls that can be accessed through an Internet browser. Include at least three levels of password protection. Include an egress lighting option that will provide each user with a lighted path for exiting the building after normal working hours.

Interoperability: Lighting control shall be configured to allow individual users to turn lighting on and off with DALI-compliant, digital-communication devices. Software shall be written for Windows operating system, with the full suite of DALI commands and device parameter settings.

System Memory: Nonvolatile. System shall reboot program and reset time automatically without errors after power outages up to 90 days' duration.

Software: Lighting control software shall be capable of linking switch inputs to relay outputs, retrieving links, viewing relay output status, controlling relay outputs, simulating switch inputs, setting device addresses, and assigning switch input and relay output modes.

Automatic Time Adjustment: System shall automatically adjust for leap year and daylight saving time and shall provide weekly routine and annual holiday scheduling.

Astronomic Control: Automatic adjustment of dawn and dusk switching.

Demand Control: Demand shall be monitored through pulses from a remote meter and shall be controlled by programmed switching of loads. System capability shall include sliding window averaging and programming of load priorities and characteristics. Minimum of two different time-of-day demand schedules shall execute load-management control actions by switching output circuits or by transmitting other types of load-control signals.

Confirmation: Each relay or contactor device operated by system shall have auxiliary contacts that provide a confirmation signal to the system of on or off status of device. On or off status confirmation for each electrically operated circuit breaker shall be provided by an auxiliary contact or by a sensing device at load terminal.

Software shall interpret status signals, provide for their display, and initiate failure signals.

Lamp or LED at control module or display panel shall identify status of each controlled circuit.

Remote Communication Capability: Allow programming, data-gathering interrogation, status display, and controlled command override from a PC at a remote location over data links. System shall include modem, communications and control software, and remote computer compatibility verification for this purpose.

Telephone Override Capability: Override programmed lighting shutdown commands by telephoning computer and shall enter a voice-menu-guided, override touch-tone code specific to zone being controlled.

Local Override Capability: Manual, low-voltage control devices shall override programmed shutdown of lighting and shall override other programmed control for intervals that may be duration programmed.

Automatic Control of Local Override: Automatic control shall switch lighting off if lighting has been switched on by local override.

Automatic battery backup shall provide power to maintain program and system clock operation for 90 days minimum duration when power is off.

Programmed time signals shall change preset scenes and dimmer settings.

Daylight Balancing Dimming Control: Control module shall interpret variable analog signal from photoelectric sensor and shall route dimming signals to dimming LED driver control circuits. Signal shall control dimming of luminaire so illumination level remains constant as daylight contribution varies.

Daylight Compensating Switch Control: Control module shall interpret a preset threshold illumination-level signal from a photoelectric relay and shall activate relays controlling power to selected groups of luminaires to turn them on and off to maintain adjustable minimum illumination level as daylight contribution varies.

Energy Conservation: Bilevel control of special ballasts or dimming circuits to comply with local energy codes.
Flick Warning: Programmable momentary turnoff of lights shall warn that programmed shutoff will occur after a preset interval. Warning shall be repeated after a second preset interval before end of programmed override period.
Diagnostics: When system operates improperly, software shall initiate factory-programmed diagnosis of failure and display messages identifying problem and possible causes.
Additional Programming: In addition to system programming by the PC, individual control modules shall be programmable using data-entry and -retrieval (such as PCs, smart phones, personal digital assistants [PDAs], hand-held infrared programming devices, wired Ethernet hubs, wireless IEEE 802.11 hubs).

2.3 POWER DISTRIBUTION COMPONENTS

Modular Relay Panel: Comply with UL 916 (CSA C22.2, No. 205); factory assembled with modular single-pole relays, power supplies, and accessory components required for specified performance.

Cabinet: Steel with hinged, locking door.

Barriers separate low-voltage and line-voltage components.
Directory: Mounted on back of door. Identifies each relay as to load groups controlled and each programmed pilot device if any.
Control Power Supply: Transformer and full-wave rectifier with filtered dc output.

Single-Pole Relays: Mechanically held unless otherwise indicated; split-coil, momentary-pulsed type.

Low-Voltage Leads: Plug connector to the connector strip in cabinet and pilot light power where indicated.
Rated Capacity (Mounted in Relay Panel): 20 A, 125-V ac for tungsten filaments; 20 A, 277-V ac for ballasts.
Endurance: 50,000 cycles at rated capacity.
Mounting: Provision for easy removal and installation in relay cabinet.

Electrically Operated, Molded-Case Circuit-Breaker Panelboard: Comply with NEMA PB 1 and UL 50 (CSA C22.2, No. 94), UL 67 (CSA C22.2, No. 29), UL 489 (CSA C22.2, No. 65), and UL 916 (CSA C22.2, No. 205).

Cabinets: In addition to requirements specified below, comply with Division 26 Section "Panelboards."
Electrically Operated, Molded-Case Circuit Breakers: Bolt-on type.

Switching Endurance Ratings: Certified by manufacturer or by a nationally recognized testing laboratory (NRTL) for at least 20,000 open and close operations under rated load at 0.8 power factor.
Minimum 30,000 open and close operations with load equal to circuit-breaker trip rating and consisting of 100 percent tungsten filament load.
Minimum 30,000 open and close operations with load equal to circuit-breaker trip rating and consisting of 100 percent fluorescent ballasts rated for 10 percent total harmonic distortion.
Listed and labeled as complying with UL SWD, HCAR, and HID ratings by a national recognized testing laboratory (NRTL) acceptable to authorities having jurisdiction.

Line-Voltage Surge Suppression: Factory installed as an integral part of 120- and 277-V ac, solid-state control panels.

Line-Voltage Surge Suppression: Field-mounting surge suppressors that comply with Division **[26]** Section "Transient-Voltage Suppression for Low-Voltage Electrical Power Circuits" for Category A locations.

Line-Voltage Surge Suppression: Factory installed as an integral part of 120- and 277-V ac, solid-state control panels or field-mounting surge suppressors that comply with Division 26 Section "Transient-Voltage Suppression for Low-Voltage Electrical Power Circuits" for Category A locations.

2.4 MANUAL SWITCHES AND PLATES

Push-Button Switches: Modular, momentary-contact, low-voltage type.

Comply with Division 26 Section “Lighting Control Devices.”
Color: Comply with Division 26 Section "Wiring Devices."
Integral green LED pilot light to indicate when circuit is on.
Internal white LED locator light to illuminate when circuit is off.

Manual, Maintained Contact, Full- -Voltage Switch: Comply with Division 26 Section "Wiring Devices."

Wall Plates: Single and multigang plates as specified in Division 26 Section "Wiring Devices."

Legend: Engraved or permanently silk-screened on wall plate where indicated. Use designations indicated on Drawings.

2.5 CONDUCTORS AND CABLES

Power Wiring to Supply Side of Class 2 Power Source: Not smaller than No. 12 AWG, complying with Division 26 Section "Building Wire and Cable."

Classes 2 and 3 Control Cables: Multiconductor cable with copper conductors not smaller than No. 24 AWG, complying with Division 26 Section "Building Wire and Cable."

Class 1 Control Cables: Multiconductor cable with copper conductors not smaller than No. 14 AWG, complying with Division 26 Section "Building Wire and Cable."

CAT-5e or similar low voltage communication cable (per division 27 requirements) shall be yellow and black striped to avoid confusion with other building communication and data systems. Such cable shall be manufacturer furnished and tested with pre-terminated RJ-454 connectors.

PART 3 - EXECUTION

3.0 EXAMINATION

Examine lighting control system components before installation. Reject components that are wet, moisture damaged, or mold damaged.

Examine walls for suitable conditions where lighting control system components will be installed.

Proceed with installation only after unsatisfactory conditions have been corrected.

3.1 WIRING INSTALLATION

Comply with NECA 1.

Wiring Method: Install wiring in raceways except where installed in accessible ceilings. Comply with Division 26 Section "Building Wire and Cable." Minimum conduit size shall be 1/2 inch (13 mm).

Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and non-power-limited conductors according to conductor manufacturer's written instructions.

Install field-mounting transient voltage suppressors for lighting control devices in Category A locations that do not have integral line-voltage surge protection.

Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

Splices, Taps, and Terminations: Make connections only on numbered terminal strips in terminal cabinets, equipment enclosures, and in junction, pull, and outlet boxes.

3.2 IDENTIFICATION

Identify components and power and control wiring according to Division 26 Section "Electrical Identification."

3.3 FIELD QUALITY CONTROL

Testing Agency: Engage a qualified testing agency to evaluate lighting control devices and perform tests and inspections.

Manufacturer's Field Service: Engage a factory-authorized service representative to inspect**,** test, and adjust field-assembled components and equipment installation, including connections, and assist in field testing. Report results in writing.

Perform the following field tests and inspections[with the assistance of a factory-authorized service representative]:

Verify wiring connections are terminated properly.
Test for circuit continuity.
Verify programming of components.
Verify that the control module features are operational and confirm proper sequence of operation for each space.
Check operation of local override controls.
Test system diagnostics by simulating improper operation of several components selected by Architect.
Replace damaged and malfunctioning controls and equipment and retest.

3.4 ADJUSTING

Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system and to assist Owner's personnel in making program changes to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

3.5 SOFTWARE SERVICE AGREEMENT

Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

Upgrade Notice: At least 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3.6 DEMONSTRATION

Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting controls and software training for PC-based control systems. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 26 09 43

SECTION 26 22 00

DRY TYPE TRANSFORMERS

PART 1 - GENERAL

1.0 RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.1 SECTION INCLUDES

Two-winding transformers.

1.2 RELATED SECTIONS

Section 26 05 32 - Conduit: Flexible conduit connections.

Section 26 05 26 - Grounding and Bonding.

1.3 REFERENCES

NEMA ST 1 - Specialty Transformers (Except General-Purpose Type).

NEMA ST 20 - Dry-Type Transformers for General Applications.

NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment (International Electrical Testing Association).

NFPA 70 - National Electrical Code.

UL 1561 – Dry Type General Purpose and Power Transformers.

1.4 SUBMITTALS FOR REVIEW

Section 26 05 00: Procedures for submittals.

Product Data: Provide outline and support point dimensions of enclosures and accessories, unit weight, voltage, kVA, and impedance ratings and characteristics, tap configurations, insulation system type, rated temperature rise and K-factor, if applicable.

1.5 SUBMITTALS FOR INFORMATION

Section 26 05 00: Submittals for information.

Test Reports: Indicate loss data, efficiency at 25, 50, 75 and 100 percent rated load, and sound level.

Submit manufacturer's installation instructions. Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

1.6 SUBMITTALS FOR CLOSEOUT

Record actual locations of transformers in project record documents.

Provide Operation and Maintenance Manuals.

1.7 REGULATORY REQUIREMENTS

Conform to requirements of NFPA 70.

Products: Listed and classified by Underwriters Laboratories, Inc. or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.8 DELIVERY, STORAGE, AND HANDLING

Deliver, handle, store, and protect products in conformity with Section 26 05 00 and Division 1.

Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.

PART 2 - PRODUCTS

2.0 MANUFACTURERS

Acceptable Manufacturers:

General Electric.
Square-D.
Siemens.
Eaton Corporation.
Substitutions: Under provisions of Section 26 05 00.

2.1 GENERAL

Case temperature: Do not exceed 35 degrees C rise above ambient at warmest point at full load.

Winding Taps:

Transformers 15 kVA and Larger: NEMA ST 20.

Sound Levels:

kVA Rating	Noise Levels (dB)
0-9	50
10-50	50
51-150	50
151-300	55
301-500	60

Basic Impulse Level: 10 kV for transformers less than 300 kVA,

Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.

Mounting:

15 kVA: Suitable for wall mounting.
16-75 kVA: Suitable for wall, floor or trapeze mounting.
Larger than 75 kVA: Suitable for floor mounting.

Coil Conductors: Continuous copper windings with terminations brazed or welded.

Enclosure: NEMA ST 20, Indoor Installations - Type 1; Provide lifting eyes or brackets.

Isolate core and coil from enclosure using vibration-absorbing mounts.

Nameplate: Include transformer connection data and overload capacity based on rated allowable temperature rise.

2.2 TWO-WINDING TRANSFORMERS

Description: NEMA ST 20, factory-assembled, air cooled dry type transformers, ratings as indicated.

Insulation system and average winding temperature rise for rated kVA as follows:

15-500 kVA: Class 220 with 150 degrees C rise.

PART 3 - EXECUTION

3.0 INSTALLATION

Set transformer plumb and level.

Use flexible conduit, under the provisions of Section 26 05 32, 3-foot maximum length, for connections to transformer case. Make conduit connections to side panel of enclosure.

Mount wall-mounted transformers using integral flanges or accessory brackets furnished by the manufacturer.

Mount transformers on vibration isolating pads suitable for isolating the transformer noise from the building structure.

Mount trapeze-mounted transformers as indicated.

Provide grounding and bonding in accordance with Section 26 05 26.

3.1 FIELD QUALITY CONTROL

Inspect and test in accordance with NETA ATS, except Section 4.

Perform inspections and tests listed in NETA ATS, Section 7.2.

3.2 ADJUSTING

Measure primary and secondary voltages and make appropriate tap adjustments.

END OF SECTION 26 22 00

SECTION 26 24 13
SWITCHBOARDS

PART 1 - GENERAL

1.0 RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.1 SUMMARY

This Section includes service and distribution switchboards rated 600 V and less.

1.2 DEFINITIONS

EMI: Electromagnetic interference.

GFCI: Ground-fault circuit interrupter.

RFI: Radio-frequency interference.

RMS: Root mean square.

SPDT: Single pole, double throw.

1.3 SUBMITTALS

Product Data: For each type of switchboard, overcurrent protective device, transient voltage suppression device, ground-fault protector, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

Shop Drawings: For each switchboard and related equipment.

Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:

Enclosure types and details for types other than NEMA 250, Type 1.
Bus configuration, current, and voltage ratings.
Short-circuit current rating of switchboards and overcurrent protective devices.
Descriptive documentation of optional barriers specified for electrical insulation and isolation.
Utility company's metering provisions with indication of approval by utility company.
Mimic-bus diagram.
UL listing for series rating of installed devices.
Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

Wiring Diagrams: Power, signal, and control wiring.

Samples: Representative portion of mimic bus with specified finish, for color selection.

Qualification Data: For testing agency.

Field quality-control test reports including the following:

Test procedures used.
Test results that comply with requirements.
Results of failed tests and corrective action taken to achieve test results that comply with requirements.

Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

Routine maintenance requirements for switchboards and all installed components.
Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
Time-current curves, including selectable ranges for each type of overcurrent protective device.

1.4 QUALITY ASSURANCE

Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7.

Source Limitations: Obtain switchboards through one source from a single manufacturer.

Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

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.

Comply with NEMA PB 2, "Deadfront Distribution Switchboards."

Comply with NFPA 70.

1.5 DELIVERY, STORAGE, AND HANDLING

Deliver in sections or lengths that can be moved past obstructions in delivery path.

Store indoors in clean dry space with uniform temperature to prevent condensation. Protect from exposure to dirt, fumes, water, corrosive substances, and physical damage.

If stored in areas subjected to weather, cover switchboards to provide protection from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside switchboards; install electric heating (250 W per section) to prevent condensation.

Handle switchboards according to NEMA PB 2.1 and NECA 400.

1.6 PROJECT CONDITIONS

Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.

Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:

Ambient Temperature: Not exceeding 104 deg F.
Altitude: Not exceeding 4400 feet.

Service Conditions: NEMA PB 2, usual service conditions, as follows:

Ambient temperatures within limits specified.
Altitude not exceeding 4400 feet.

1.7 COORDINATION

Coordinate layout and installation of switchboards and components with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.8 EXTRA MATERIALS

Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

Potential Transformer Fuses: Equal to 10 percent of amount installed for each size and type, but no fewer than 2 of each size and type.
Control-Power Fuses: Equal to 10 percent of amount installed for each size and type, but no fewer than 2 of each size and type.
Fuses and Fusible Devices for Fused Circuit Breakers: Equal to 10 percent of amount installed for each size and type, but no fewer than 3 of each size and type.
Fuses for Fused Power-Circuit Devices: Equal to 10 percent of amount installed for each size and type, but no fewer than 3 of each size and type.
Indicating Lights: Equal to 10 percent of amount installed for each size and type, but no fewer than 1 of each size and type.

PART 2 - PRODUCTS

2.0 MANUFACTURERS

In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.1 MANUFACTURED UNITS

Manufacturers:

Eaton Corporation
General Electric Co.; Electrical Distribution & Protection Div.
Siemens Energy & Automation, Inc.
Square D.

Front- and Side-Accessible Switchboard: Fixed, individually mounted main device; panel-mounted branches; and sections rear aligned.

Nominal System Voltage: 480Y/277 V.

Main-Bus Continuous: 3000 A.

Enclosure: Steel, NEMA 250, Type 1.

Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

Barriers: Between adjacent switchboard sections.

Insulation and isolation for main bus of main section and main and vertical buses of feeder sections.

Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.

Pull Box on Top of Switchboard:

Adequate ventilation to maintain temperature in pull box within same limits as switchboard.
Set back from front to clear circuit-breaker removal mechanism.
Removable covers shall form top, front, and sides. Top covers at rear shall be easily removable for drilling and cutting.
Bottom shall be insulating, fire-resistive material with separate holes for cable drops into switchboard.
Cable supports shall be arranged to facilitate cabling and adequate to support cables indicated, including those for future installation.

Buses and Connections: Three phase, four wire, unless otherwise indicated.

Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity with feeder circuit-breaker line connections.

If bus is copper, use copper for feeder circuit-breaker line connections.

Load Terminals: Insulated, rigidly braced, silver-plated, copper runback bus extensions equipped with pressure connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full ampere rating of circuit-breaker position.

Ground Bus: 1/4-by-2-inch-minimum-size, hard-drawn copper of 98 percent conductivity, equipped with pressure connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.

Contact Surfaces of Buses: Silver plated.

Main Phase Buses, Neutral Buses, and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.

Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.

Neutral Buses: 100 percent of the ampacity of phase buses, unless otherwise indicated, equipped with pressure connectors for outgoing circuit neutral cables. Bus extensions for busway feeder neutral bus are braced.

Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

Bus-Bar Insulation: Factory-applied, flame-retardant, tape wrapping of individual bus bars or flame-retardant, spray-applied insulation. Minimum insulation temperature rating: 105 deg C.

2.2 OVERCURRENT PROTECTIVE DEVICES

Molded-Case Circuit Breaker: NEMA AB 3, with interrupting capacity to meet available fault currents.

Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

Electronic trip-unit circuit breakers shall have RMS sensing, field-replaceable rating plug, and the following field-adjustable settings:

Instantaneous trip.
Long- and short-time pickup levels.
Long- and short-time time adjustments.
Ground-fault pickup level, time delay, and I^2t response.

Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.

Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.

GFCI Circuit Breakers: Single- and two-pole configurations with 5-mA trip sensitivity.

Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.

Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.
Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.

Enclosed, Insulated-Case Circuit Breaker: Fully rated, encased-power circuit breaker with interrupting capacity rating to meet available fault current.

Fixed circuit-breaker mounting.
Two-step, stored-energy closing.
Microprocessor-based trip units with interchangeable rating plug, LED trip indicators, and the following field-adjustable settings:

Instantaneous trip.
Long- and short-time pickup levels.
Long- and short-time time adjustments with I^2t response.
Ground-fault pickup level, time delay, and I^2t response.

Remote trip indication and control.
Control Voltage: 125-V, ac.

2.3 INSTRUMENTATION

Instrument Transformers: NEMA EI 21.1, IEEE C57.13, and the following:

Potential Transformers: Secondary voltage rating of 120 V and NEMA accuracy class of 0.3 with burdens of W, X, and Y.
Current Transformers: Ratios shall be as indicated with accuracy class and burden suitable for connected relays, meters, and instruments.
Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kV.
Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondaries to ground overcurrent relays to provide selective tripping of main and tie circuit breaker. Coordinate with feeder circuit-breaker ground-fault protection.

Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:

Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:

Phase Currents, Each Phase: Plus or minus 1 percent.
Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
Megawatts: Plus or minus 2 percent.
Megavars: Plus or minus 2 percent.
Power Factor: Plus or minus 2 percent.
Frequency: Plus or minus 0.5 percent.
Megawatt Demand: Plus or minus 2 percent; demand interval programmable from 5 to 60 minutes.
Accumulated Energy, Megawatt Hours: Plus or minus 2 percent. Accumulated values unaffected by power outages up to 72 hours.

Mounting: Display and control unit flush or semi-flush mounted in instrument compartment door.
Protocols: Modbus ASCII, RTU or DNP 3.0 and/or Compatible with building automation system (BAS) protocol.

Ammeters, Voltmeters, and Power-Factor Meters: ANSI C39.1.

Meters: 4-inch diameter or 6 inches square, flush or semi-flush, with antiparallax 250-degree scales and external zero adjustment.
Voltmeters: Cover an expanded-scale range of nominal voltage plus 10 percent.

Instrument Switches: Rotary type with off position.

Voltmeter Switches: Permit reading of all phase-to-phase voltages and, where a neutral is indicated, phase-to-neutral voltages.
Ammeter Switches: Permit reading of current in each phase and maintain current-transformer secondaries in a closed-circuit condition at all times.

Feeder Ammeters: 2-1/2-inch-minimum size with 90- or 120-degree scale. Meter and transfer device with an off position, located on overcurrent device door for indicated feeder circuits only.

Watt-Hour Meters: Flush or semi-flush type, rated 5 A, 120 V, 3 phase, 3 wire, with 3 elements, 15-minute-indicating-demand register, and provision for testing and adding pulse initiation.

Recording Demand Meter: Usable as totalizing relay or as indicating and recording maximum-demand meter with 15-minute interval. Meter shall count and control a succession of pulses entering two channels. House in drawout, back-connected case arranged for semi-flush mounting.

2.4 CONTROL POWER

Control Circuits: 120 V, supplied through secondary disconnecting devices from control-power transformer.

Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.

Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

2.5 ACCESSORY COMPONENTS AND FEATURES

Furnish accessory set including tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

Furnish portable test set to test functions of solid-state trip devices without removal from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.

Furnish one portable, floor-supported, roller-based, elevating carriage arranged for movement of circuit breakers in and out of compartments for present and future circuit breakers.

Spare-Fuse Cabinet: Suitably identified, wall-mounted, lockable, compartmented steel box or cabinet. Arrange for wall mounting.

2.6 IDENTIFICATION

Mimic Bus: Continuously integrated mimic bus factory applied to front of switchboard. Arrange in single-line diagram format, using symbols and letter designations consistent with final mimic-bus diagram. Coordinate mimic-bus segments with devices in switchboard sections to which they are applied. Produce a concise visual presentation of principal switchboard components and connections.

Presentation Media: Painted graphics in color contrasting with background color to represent bus and components, complete with lettered designations.

PART 3 - EXECUTION

3.0 PROTECTION

Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

3.1 EXAMINATION

Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance.

Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

Install switchboards and accessories according to NEMA PB 2.1 and NECA 40.

Install and anchor switchboards level on concrete bases, 4-inch nominal thickness. Concrete base is specified in Division 26 Section "Supporting Devices and Seals," and concrete materials and installation requirements are specified in Division 03.

Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.
For switchboards, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
Install anchor bolts to elevations required for proper attachment to switchboards.

Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.

Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.

Install overcurrent protective devices, transient voltage suppression devices, and instrumentation.

Set field-adjustable switches and circuit-breaker trip ranges.

Install spare-fuse cabinet.

3.3 IDENTIFICATION

Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Electrical Identification."

Switchboard Nameplates: Label each switchboard compartment with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws as specified in Division 26 Section “Electrical Identification.”

3.4 FIELD QUALITY CONTROL

Prepare for acceptance tests as follows:

Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.
Test continuity of each circuit.

Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:

Perform the following field tests and inspections and prepare test reports:

Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Sections 7.1, 7.5, 7.6, 7.9, 7.10, 7.11, and 7.14 as appropriate. Certify compliance with test parameters.
Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
Perform the following infrared scan tests and inspections and prepare reports:

Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchboard. Remove front panels so joints and connections are accessible to portable scanner.
Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchboard 11 months after date of Substantial Completion.
Instruments, Equipment, and Reports:

Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
Prepare a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 CLEANING

On completion of installation, inspect interior and exterior of switchboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

3.6 DEMONSTRATION

Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 26 24 13

SECTION 26 24 16
PANELBOARDS

PART 1 - GENERAL

1.0 RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.1 SUMMARY

This Section includes the following:

- Distribution panelboards.
- Lighting and appliance branch-circuit panelboards.
- Transient voltage suppression panelboards.

1.2 DEFINITIONS

EMI: Electromagnetic interference.

GFCI: Ground-fault circuit interrupter.

RFI: Radio-frequency interference.

RMS: Root mean square.

SPDT: Single pole, double throw.

1.3 SUBMITTALS

Product Data: For each type of panelboard, overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

Shop Drawings: For each panelboard and related equipment.

Dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings. Include the following:

- Enclosure types and details for types other than NEMA 250, Type 1.
- Bus configuration, current, and voltage ratings.
- Short-circuit current rating of panelboards and overcurrent protective devices.
- UL listing for series rating of installed devices.
- Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

Wiring Diagrams: Power, signal, and control wiring.

Provide shop drawings for complete electrical room panel layouts based on equipment size per the construction documents. Construction document layouts to be maintained for future equipment space considerations. Deviations from the construction documents to be brought to the engineer for review prior to installation.

Qualification Data: For testing agency.

Field quality-control test reports including the following:

Test procedures used.
Test results that comply with requirements.
Results of failed tests and corrective action taken to achieve test results that comply with requirements.

Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
Time-current curves, including selectable ranges for each type of overcurrent protective device.

1.4 QUALITY ASSURANCE

Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories through one source from a single manufacturer.

Product Options: Drawings indicate size, profiles, and dimensional requirements of panelboards and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

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.

Comply with NEMA PB 1.

Comply with NFPA 70.

1.5 PROJECT CONDITIONS

Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:

Ambient Temperature: Not exceeding 104 deg F.
Altitude: Not exceeding 4400 feet.

Service Conditions: NEMA PB 1, usual service conditions, as follows:

Ambient temperatures within limits specified.
Altitude not exceeding 4400 feet.

1.6 COORDINATION

Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, and encumbrances to workspace clearance requirements.

Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.7 EXTRA MATERIALS

Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

Keys: Six spares for each type of panelboard cabinet lock.

PART 2 - PRODUCTS

2.0 MANUFACTURERS

Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

Manufacturers: Subject to compliance with requirements, provide products by one of the following:

Panelboards, Overcurrent Protective Devices, Controllers, Contactors, and Accessories:

Eaton Corporation
General Electric Co.; Electrical Distribution & Protection Div.
Siemens Energy & Automation, Inc.
Square D.

Transient Voltage Suppression Panelboards:

Current Technology.
Liebert Corporation.

2.1 MANUFACTURED UNITS

Enclosures: Flush- and surface-mounted cabinets. NEMA PB 1, Type 1.

Rated for environmental conditions at installed location.

Outdoor Locations: NEMA 250, Type 3R.
Other Wet or Damp Indoor Locations: NEMA 250, Type 4.

Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.

Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
Finish: Manufacturer's standard enamel finish over corrosion-resistant treatment or primer coat.
Directory Card: With transparent protective cover, mounted in metal frame, inside panelboard door.

Phase and Ground Buses:

Material: Hard-drawn copper, 98 percent conductivity.
Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors; bonded to box.
Isolated Equipment Ground Bus: Adequate for branch-circuit equipment ground conductors; insulated from box.
Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.
Split Bus: Vertical buses divided into individual vertical sections.

Conductor Connectors: Suitable for use with conductor material.

Main and Neutral Lugs: Compression type.
Ground Lugs and Bus Configured Terminators: Compression type.
Feed-Through Lugs: Compression type suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.

Future Devices: Mounting brackets, bus connections, and necessary appurtenances required for future installation of devices.

2.2 PANELBOARD SHORT-CIRCUIT RATING

UL label indicating series-connected rating with integral or remote upstream overcurrent protective devices. Include size and type of upstream device allowable, branch devices allowable, and UL series-connected short-circuit rating.

Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.3 DISTRIBUTION PANELBOARDS

Doors: Secured with vault-type latch with tumbler lock; keyed alike. Omit for fused-switch panelboards.

Main Overcurrent Protective Devices: Circuit breaker.

Branch Overcurrent Protective Devices:

For Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.
For Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.5 TRANSIENT VOLTAGE SUPPRESSION PANELBOARDS

Doors: Secured with vault-type latch with tumbler lock; keyed alike.

Main Overcurrent Devices: Thermal-magnetic circuit breaker.

Branch Overcurrent Protective Devices: Bolt-on circuit breakers.

Bus: Copper phase and neutral buses; 200 percent capacity neutral bus and lugs.

Transient Voltage Suppression Device: IEEE C62.41, integrally mounted, plug-in-style, solid-state, parallel-connected, sine-wave tracking suppression and filtering modules.

Minimum Single-Impulse Current Ratings:

Line to Neutral: 100,000 A.
Line to Ground: 100,000 A.
Neutral to Ground: 50,000 A.

Protection modes shall be as follows:

Line to neutral.
Line to ground.
Neutral to ground.

EMI/RFI Noise Attenuation Using 50-ohm Insertion Loss Test: 55 dB at 100 kHz.
Maximum Category C Combination Wave Clamping Voltage: 600 V, line to neutral and line to ground on 120/208 V; 1000 V, line to neutral and line to ground on 277/480 V systems.
Maximum UL 1449 Clamping Levels: 400 V, line to neutral and line to ground on 120/208 V; 800 V, line to neutral and line to ground on 277/480 V systems.
Withstand Capabilities: 3000 Category C surges with less than 5 percent change in clamping voltage.
Accessories:

Form-C contacts, one normally open and one normally closed, for remote monitoring of system operation. Contacts to reverse position on failure of any surge diversion module.
Audible alarm activated on failure of any surge diversion module.
Six-digit transient-counter set to total transient surges that deviate from the sine-wave envelope by more than 125 V.

2.6 OVERCURRENT PROTECTIVE DEVICES

Molded-Case Circuit Breaker: UL 489, with interrupting capacity to meet available fault currents.

Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

Electronic trip-unit circuit breakers shall have RMS sensing; field-replaceable rating plug; and with the following field-adjustable settings:

Instantaneous trip.
Long- and short-time pickup levels.
Long- and short-time time adjustments.
Ground-fault pickup level, time delay, and I^2t response.

Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.
GFCI Circuit Breakers: Single- and two-pole configurations with 5 or 30-mA trip sensitivity. Refer to drawings for additional information.

Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.

Lugs: Compression style, suitable for number, size, trip ratings, and conductor materials.
Application Listing: Appropriate for application; Type HACR for heating, air-conditioning, and refrigerating equipment.
Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
Multipole units enclosed in a single housing or factory-assembled to operate as a single unit.

2.7 ACCESSORY COMPONENTS AND FEATURES

Furnish accessory set including tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

Furnish portable test set to test functions of solid-state trip devices without removal from panelboard.

PART 3 - EXECUTION

3.0 INSTALLATION

Install panelboards and accessories according to NEMA PB 1.1.

Mount top of trim 74 inches above finished floor, unless otherwise indicated.

Mount plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish. Surface mounted panelboards to be supported with Unistrut from floor to ceiling structure. Mounting of panelboards directly to drywall surfaces is not acceptable.

Install overcurrent protective devices and controllers.

Set field-adjustable switches and circuit-breaker trip ranges.

Install filler plates in unused spaces.

Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.

Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

3.1 IDENTIFICATION

Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Electrical Identification."

Create a directory to indicate installed circuit loads after balancing panelboard loads. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

Panelboard Nameplates: Label each panelboard with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

3.2 CONNECTIONS

Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

Connect wiring according to Division 26 Section "Building Wire and Cable."

3.3 FIELD QUALITY CONTROL

Prepare for acceptance tests as follows:

Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
Test continuity of each circuit.

Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:

Perform the following field tests and inspections and prepare test reports:

Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.

Measure as directed during period of normal system loading.
Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scanning of each panelboard. Remove panel fronts so joints and connections are accessible to portable scanner. Scanning reports to be included in the O&M's

Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.

Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

Record of Infrared Scanning: Prepare a certified report that identifies panelboards checked and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action. Reports to be compared with initial scanning reports for comparison and submitted to the owner for record.

3.4 CLEANING

On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION 26 24 16

SECTION 26 27 26
WIRING DEVICES

PART 1 - GENERAL

1.0 RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.1 SUMMARY

This Section includes the following:

- Receptacles, receptacles with integral GFCI, and associated device plates.
- Twist-locking receptacles.
- Tamper-resistant receptacles.
- Weather-resistant receptacles.
- Toggle switches.
- Solid-state fan speed controls.
- Pendant cord-connector devices.
- Cord and plug sets.
- Floor service outlets, poke-through assemblies, service poles, and multioutlet assemblies.

Related Sections include the following:

- Division 27 Section "Communications Horizontal Cabling" for workstation outlets.

1.2 DEFINITIONS

EMI: Electromagnetic interference.

GFCI: Ground-fault circuit interrupter.

Pigtail: Short lead used to connect a device to a branch-circuit conductor.

RFI: Radio-frequency interference.

SPD: Surge Protective Device.

UTP: Unshielded twisted pair.

1.3 SUBMITTALS

Product Data: For each type of product indicated.

Shop Drawings: List of legends and description of materials and process used for pre-marking wall plates.

Field quality-control test reports.

Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1.4 QUALITY ASSURANCE

Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.

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.

Comply with NFPA 70.

1.5 COORDINATION

Receptacles for Owner-Furnished Equipment: Match plug configurations.

Cord and Plug Sets: Match equipment requirements.

1.6 EXTRA MATERIALS

Furnish extra materials described in subparagraphs below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

Floor Service Outlet Assemblies: One for every 10, but no fewer than one.
Poke-Through, Fire-Rated Closure Plugs: One for every five floor service outlets installed, but no fewer than two.
SPD Receptacles: One for every 10 of each type installed, but no fewer than two of each type.

PART 2 - PRODUCTS

2.0 STRAIGHT-BLADE RECEPTACLES

Manufacturers' Names: Shortened versions (shown in parentheses)

Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
Leviton Mfg. Company Inc. (Leviton).
Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.

Description: Heavy duty, straight blade, single-piece, high strength nylon face with finder grooves and brass heavy duty grounding straps. Back and side wired to accept #12 AWG through #10 AWG solid conductors.

Tamper-Resistant Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498 Supplement sd, and FS W-C-596.

Description: Heavy duty, straight blade, single-piece, high strength nylon face with finder grooves, rivetless, nickel-plated, all-brass grounding system, spring loaded shutters. Nickel-plated, brass mounting strap. Back and side wired to accept #12 AWG through #10 AWG solid conductors.

2.1 GFCI RECEPTACLES

Manufacturers' Names: Shortened versions (shown in parentheses)

Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
Leviton Mfg. Company Inc. (Leviton).
Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

Duplex GFCI Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498 Supplement sd, UL 943 Class A, and FS W-C-596.

Description: Heavy duty, straight blade, Non-feed-through type, high strength nylon face and brass heavy duty grounding straps. Indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection. Back and side wired to accept #12 AWG through #10 AWG solid conductors.

Tamper-Resistant Duplex GFCI Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498 Supplement sd, UL 943 Class A, and FS W-C-596.

Description: Heavy duty, straight blade, non-feed-through type, high strength nylon face, spring loaded shutters, and brass heavy duty grounding straps. Indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection. Back and side wired to accept #12 AWG through #10 AWG solid conductors.

Weather-Resistant Duplex GFCI Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498 Supplement sd, UL 943 Class A, and FS W-C-596.

Description: Heavy duty, straight blade, non-feed-through type, high strength UV resistant nylon face and brass heavy duty grounding straps. Indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection. Back and side wired to accept #12 AWG through #10 AWG solid conductors.

2.2 TWIST-LOCKING RECEPTACLES

Manufacturers' Names: Shortened versions (shown in parentheses)

Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
Leviton Mfg. Company Inc. (Leviton).
Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration L5-20R, and UL 498.

Description: Twist-locking, single-piece, high impact nylon face with color coded voltage indicator and brass heavy duty grounding straps. Back and side wired to accept #12 AWG through #10 AWG solid conductors.

2.3 CORD AND PLUG SETS

Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.

Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30 percent.
Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.4 TOGGLE SWITCHES

Manufacturers' Names: Shortened versions (shown in parentheses)

Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
Leviton Mfg. Company Inc. (Leviton).
Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

Single Pole Switches, 120/277 V, 20 A: Comply with NEMA WD 1, UL 20, and FS W-S-896.

Description: Heavy duty specification grade, with thermoplastic polycarbonate toggle and heavy duty toggle bumpers for smooth and quiet operation, amperage marking on face. Back and side wired to accept #12 AWG through #10 AWG solid conductors.

Two Pole Switches, 120/277 V, 20 A: Comply with NEMA WD 1, UL 20, and FS W-S-896.

Description: Heavy duty specification grade, with thermoplastic polycarbonate toggle and heavy duty toggle bumpers for smooth and quiet operation, amperage marking on face. Back and side wired to accept #12 AWG through #10 AWG solid conductors.

Three Way Switches, 120/277 V, 20 A: Comply with NEMA WD 1, UL 20, and FS W-S-896.

Description: Heavy duty specification grade, with thermoplastic polycarbonate toggle and heavy duty toggle bumpers for smooth and quiet operation, amperage marking on face. Back and side wired to accept #12 AWG through #10 AWG solid conductors.

Four Way Switches, 120/277 V, 20 A: Comply with NEMA WD 1, UL 20, and FS W-S-896.

Description: Heavy duty specification grade, with thermoplastic polycarbonate toggle and heavy duty toggle bumpers for smooth and quiet operation, amperage marking on face. Back and side wired to accept #12 AWG through #10 AWG solid conductors.

Pilot-Light Switches, 20 A: Comply with NEMA WD 1, UL 20, and FS W-S-896.

Description: Heavy duty specification grade, single pole, with thermoplastic polycarbonate illuminated toggle, illuminated when switch is “on” toggle and heavy duty toggle bumpers for smooth and quiet operation, amperage marking on face. Back and side wired to accept #12 AWG through #10 AWG solid conductors.

Key-Operated Switches, 120/277 V, 20 A: Comply with NEMA WD 1, UL 20, and FS W-S-896.

Description: Heavy duty specification grade, single pole, with factory-supplied key in lieu of switch handle and heavy duty toggle bumpers for smooth and quiet operation, amperage marking on face. Back and side wired to accept #12 AWG through #10 AWG solid conductors.

Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches: 120/277 V, 20 A: Comply with NEMA WD 1, UL 20, and FS W-S-896.

Description: Heavy duty specification grade, with thermoplastic polycarbonate toggle and heavy duty toggle bumpers for smooth and quiet operation, amperage marking on face. Side wired to accept #12 AWG through #10 AWG solid conductors.

Key-Operated, Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches: 120/277 V, 20 A; for use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.

Description: Heavy duty specification grade, with factory-supplied key in lieu of switch handle and heavy duty toggle bumpers for smooth and quiet operation, amperage marking on face. Side wired to accept #12 AWG through #10 AWG solid conductors.

Fan Speed Controls:

Modular, 120-V, full-wave, solid-state units with integral, quiet on-off switches and audible frequency and EMI/RFI filters.
Comply with UL 1917.
Continuously adjustable toggle switch, 5 A.
Three-speed adjustable slider, 1.5 A.

2.5 WALL PLATES

Single and combination types shall match corresponding wiring devices.

Plate-Securing Screws: Metal with head color to match plate finish.
Material for Finished Spaces: Smooth, high-impact thermoplastic 0.035-inch-thick, satin-finished, Type 302 stainless steel.
Material for Unfinished Spaces: Smooth, high-impact thermoplastic.
Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in we t and damp locations.

Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover.

2.6 FLOOR SERVICE FITTINGS

Type: As specified on drawings.

Compartments: Barrier separates power from voice and data communication cabling.

Service Plate: As specified on drawings with satin finish.

Power Receptacle: NEMA WD 6 Configuration 5-20R, gray finish, unless otherwise indicated.

2.7 POKE-THROUGH ASSEMBLIES

Manufacturers: Subject to compliance with requirements, provide products by one of the following:

Hubbell Incorporated; Wiring Device-Kellems
Pass & Seymore/Legrand
Square D/Schneider Electric
Thomas & Betts Corporation
Wiremold/Legrand

Description:

Factory-fabricated and -wired assembly of below-floor junction box with multi-channeled, through-floor raceway/firestop unit and detachable matching floor service-outlet assembly.
Comply with UL 514 scrub water exclusion requirements.
Service-Outlet Assembly: As specified on drawings and complying with requirements in Section 27 15 00 "Communications Horizontal Cabling."
Size: Selected to fit nominal 3-inch cored holes in floor and matched to floor thickness.
Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.
Closure Plug: Arranged to close unused 3-inch cored openings and reestablish fire rating of floor.
Wiring Raceways and Compartments: For a minimum of four No. 12 AWG conductors and a minimum of four, four-pair cables that comply with requirements in Section 27 15 00 "Communications Horizontal Cabling."

2.8 FINISHES

Device Color:

Wiring Devices Connected to Normal Power System: As selected by Architect unless otherwise indicated or required by NFPA 70 or device listing.
Wiring Devices Connected to Emergency Power System: Red.

Wall Plate Color: For plastic covers, match device color.

PART 3 - EXECUTION

3.0 INSTALLATION

Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.

Coordination with Other Trades:

Take steps to ensure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
Install wiring devices after all wall preparation, including painting, is complete.

Conductors:

Do not strip insulation from conductors until just before they are spliced or terminated on devices.
Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
Existing Conductors:

Cut back and pigtail or replace all damaged conductors.
Straighten conductors that remain and remove corrosion and foreign matter.
Pig-tailing existing conductors is permitted provided the outlet box is large enough.

Device Installation:

Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
Use a torque screwdriver when a torque is recommended or required by the manufacturer.
When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
Tighten unused terminal screws on the device.
When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.
Install wall switches 42 inches above floor, OFF position down.
Install convenience receptacles 18 inches above floor, 2 inches above counters or backsplash, grounding pole on bottom.
The use of devices with prefabricated wiring termination is not permitted.

Receptacle Orientation:

Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.

Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multi-gang wall plates.

Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.1 IDENTIFICATION

Comply with Division 26 Section "Identification for Electrical Systems."

Receptacles and Switches: Identify panelboard and circuit number from which served.

3.2 FIELD QUALITY CONTROL

Perform tests and inspections.

Test Instruments: Use instruments that comply with UL 1436.

Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

Tests for Convenience Receptacles:

Line Voltage: Acceptable range is 105 to 132 V.

Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.

Ground Impedance: Values of up to 2 ohms are acceptable.

GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.

Using the test plug, verify that the device and its outlet box are securely mounted.

The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

END OF SECTION 26 27 26

SECTION 26 28 13
FUSES

PART 1 - GENERAL

1.0 RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.1 SECTION INCLUDES

Fuses.

Spare fuse cabinet.

1.2 RELATED SECTIONS

Division 9: Painting of spare fuse cabinet.

1.3 REFERENCES

NFPA 70 - National Electric Code.

NEMA FU 1 - Low Voltage Cartridge Fuses.

1.4 SUBMITTALS

Submit under provisions of Section 26 05 00.

Product Data: Provide data sheets showing electrical characteristics including time-current curves.

1.5 PROJECT RECORD DOCUMENTS

Submit under provisions of Section 26 05 00.

Record actual fuse sizes.

1.6 QUALIFICATIONS

Manufacturer: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.7 REGULATORY REQUIREMENTS

Conform to requirements of NFPA 70.

Furnish products listed and classified by UL and referenced standards as suitable for purpose specified and indicated.

1.8 MAINTENANCE MATERIALS

Provide two fuse pullers.

1.9 EXTRA MATERIALS

Provide three of each size and type fuse installed.

PART 2 - PRODUCTS

2.0 MANUFACTURERS

Manufacturers:

Bussman.
Littelfuse.
Ferraz-Shawmut.
Substitutions: Under provisions of Division 1.

2.1 FUSE REQUIREMENTS

Dimensions and Performance: NEMA FU 1, Class as specified or indicated.

Voltage: Provide fuses with voltage rating suitable for circuit phase-to-phase voltage.

Motor Load Feeder Switches: Class RK1 (time delay).

Power Branch Circuits: Class RK1 [(time delay).

Motor Branch Circuits: Class RK1 (time delay).

Lighting Branch Circuits: Class G.

2.2 SPARE FUSE CABINET

Description: Wall-mounted sheet metal cabinet, suitably sized to store spare fuses and fuse pullers specified.

Doors: Hinged, with hasp for Owner's padlock.

Finish: Prime finish for field painting.

PART 3 - EXECUTION

3.0 INSTALLATION

Install fuses in accordance with manufacturer's instructions.

Install fuse with label oriented such that manufacturer, type, and size are easily read.

Install spare fuse cabinet where indicated on drawings.

END OF SECTION 26 28 13

SECTION 26 28 16
ENCLOSED SWITCHES

PART 1 - GENERAL

1.0 RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.1 SECTION INCLUDES

Fusible Switches

Nonfusible Switches

1.2 RELATED SECTIONS

Section 26 28 13- Fuses.

1.3 REFERENCES

NECA - Standard of Installation (published by the National Electrical Contractors Association).

NEMA FU1 - Low Voltage Cartridge Fuses.

NEMA KS1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).

NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems (published by the International Electrical Testing Association).

NFPA 70 - National Electrical Code.

1.4 SUBMITTALS FOR REVIEW

Section 26 05 00: Procedures for submittals.

Product Data: Provide switch ratings and enclosure dimensions.

1.5 SUBMITTALS FOR CLOSEOUT

Record actual locations of enclosed switches in project record documents.

1.6 QUALIFICATIONS

Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1.7 REGULATORY REQUIREMENTS

Conform to requirements of NFPA 70.

Products: Listed and classified by Underwriters Laboratories, Inc. or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.0 MANUFACTURERS

Acceptable Manufacturers

Eaton Corporation
General Electric
Square-D
Siemens
Substitutions: Under provisions of Section 26 05 00.

2.1 FUSIBLE SWITCH ASSEMBLIES

Description: NEMA KS 1, Type HD with externally operable handle interlocked to prevent opening front cover with switch in ON position, enclosed load interrupter knife switch. Handle lockable in OFF position.

Fuse Clips: Not allowed.

2.2 NONFUSIBLE SWITCH ASSEMBLIES

Description: NEMA KS 1, Type HD with externally operable handle interlocked to prevent opening front cover with switch in ON position enclosed load interrupter knife switch. Handle lockable in OFF position.

2.3 ENCLOSURES

Fabrication: NEMA KS 1.

Interior Dry Locations: Type 1.
Exterior Locations: Type 3R.
Elevator Locations: Type 4X.

PART 3 - EXECUTION

3.0 INSTALLATION

Install in accordance with NECA "Standard of Installation".

Install fuses in fusible disconnect switches.

Apply adhesive tag on inside door of each fused switch indicating NEMA fuse class and size installed.

3.1 FIELD QUALITY CONTROL

Inspect and test in accordance with NETA ATS, except Section 4.

Perform inspections and tests listed in NETA ATS, Section 7.5.

END OF SECTION 26 28 16

SECTION 26 29 13

MOTOR CONTROLLERS

PART 1 - GENERAL

1.0 RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.1 SUMMARY

Manual motor starters.

Magnetic motor starters.

Combination magnetic motor starters.

Reduced Voltage Starters

1.2 RELATED SECTIONS

Divisions 22 and 23 – Mechanical/Electrical Requirements for Mechanical Equipment

1.3 REFERENCE STANDARDS

Comply with the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents. A listing of applicable reference standards is contained in Division 1.

ANSI/NEMA ICS 6 – 1993: Industrial Control and Systems: Enclosures

NEMA AB 1 - Molded Case Circuit Breakers.

NEMA ICS 2 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays.

1.4 SUBMITTALS (Refer Division 1)

Submit under provisions of Section 26 05 00.

Provide product data on motor starters and combination motor starters, relays, pilot devices, and switching and overcurrent protective devices.

1.5 OPERATION AND MAINTENANCE DATA

Submit operation and maintenance data under provisions of Section 26 05 00.

Include spare parts data listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

1.6 DELIVERY, STORAGE, AND HANDLING

Deliver products to site under provisions of Division 1.

Store and protect products under provisions of Section 26 05 00.

PART 2 - PRODUCTS

2.0 ACCEPTABLE MANUFACTURERS

Motor Starters

- Allen-Bradley
- Eaton Corporation
- Square-D
- Siemens

2.1 MANUAL MOTOR STARTERS

Manual Motor Starter: NEMA ICS 2; AC general-purpose Class A manually operated non-reversing full-voltage controller for induction motors rated in horsepower, with overload relay for each phase, low-voltage protection, red pilot light, field-convertible auxiliary contact, and toggle operator.

Fractional Horsepower Manual Starter: NEMA ICS 2; AC general-purpose Class A manually operated, full-voltage controller for fractional horsepower induction motors, with thermal overload unit, red pilot light, and key or toggle operator as indicated.

Motor Starting Switch: NEMA ICS 2; AC general-purpose Class A manually operated pole, full-voltage controller for fractional horsepower induction motors, without thermal overload unit, red pilot light, field convertible auxiliary contact, and toggle operator.

Enclosure: ANSI/NEMA ICS 6; Type 1 for indoor applications, and type 3R for outdoor applications.

2.2 MAGNETIC MOTOR STARTERS

Magnetic Motor Starters: NEMA ICS 2; AC general-purpose Class A, combination type magnetic controller as specified herein, for induction motors, rated in horsepower.

Magnetic Motor Starters shall be circuit breaker or motor circuit protector combination type, with external operator, in common enclosure with starter. External circuit breaker operator environmental rating shall match the enclosure rating. Disconnecting means shall be equipped with provisions enabling locking in the “OFF" position.

Full Voltage Starting: Reversing or non-reversing type as indicated.

Two-Speed Starting: Two-speed, one or two winding, and variable torque or constant torque as required to match the motor and the driven load. All two-speed motors with 2:1 ratio shall be single-winding type (refer to Divisions 22 and 23); all other two-speed motors shall be two-winding type. Division under which motor starters will be supplied is responsible for verifying motor winding configuration so as to assure proper motor starter selection. Provide two-speed/reversing starter, with reversing contactor for low-speed operation only, where indicated. Include integral time delay transition between FAST and SLOW speeds, and between FORWARD and REVERSE rotation, as applicable. Starters for motors rated 25 horsepower, or larger shall include controls forcing low-speed start followed by transition to high speed, irrespective of concurrent control systems demand for high-speed operation.

Coil Operating Voltage: Unless otherwise specified, 120 volts, 60-hertz.

Size: NEMA ICS 2; size as shown on Drawings, or as required for the motor horsepower.

Overload Relay: NEMA ICS 2; self-powered, adjustable trip electronic type, with selectable trip class operation. Motor protection functions shall include phase loss, phase unbalance, and ground fault.

Enclosure: NEMA ICS 6; Type 1 for indoor applications, and type 3R for outdoor applications.

Auxiliary Contacts: NEMA ICS 2; two field-convertible contacts in addition to seal-in contact.

Selector Switches: NEMA ICS 2; HAND/OFF/AUTO, maintained type, in front cover.

Indicating Lights: NEMA ICS 2; RUN: red LED type, in front cover with press-to-test lamp testing feature.

Relays: NEMA ICS 2; as required.

For 480-volt applications, an individually fused 480-120-volt control transformer shall be furnished with each combination starter. The control transformer shall be sized by the manufacturer to have a minimum of 20 percent capacity in excess of the continuous volt-ampere requirements of the holding coil, indicating lights and any externally located devices such as a solenoid valves, external relays, etc. The control transformer shall be capable of operation with an inrush current twenty (20) percent greater than required by the holding coil, indicating lights and external device, if any.

PART 3 - EXECUTION

3.0 INSTALLATION

Install motor control equipment in accordance with manufacturer's instructions.

Select and adjust electronic overloads to match installed motor characteristics.

Motor Data: Provide neatly typed label inside each motor starter enclosure door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating.

Floor mounted equipment shall be on a 4" concrete housekeeping pad.

Provide Name plates per Section 26 05 53.

END OF SECTION 26 29 13

SECTION 26 32 13
ENGINE GENERATORS

PART 1 - GENERAL

1.0 RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.1 SUMMARY

This Section includes packaged engine-generator sets for emergency and optional standby power supply with the following features:

- Gas engine.
- Unit-mounted cooling system.
- Unit-mounted control and monitoring.
- Performance requirements for sensitive loads.
- Load banks.
- Outdoor enclosure.

Related Sections include the following:

- Division 26 Section "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine-generator sets.

1.2 DEFINITIONS

Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

LP: Liquid petroleum.

1.3 SUBMITTALS

Product Data: For each type of packaged engine generator indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. In addition, include the following:

- Thermal damage curve for generator.
- Time-current characteristic curves for generator protective device.
- Provide compliance letter that indicates compliance and deviations from specification.

Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

- Dimensioned outline plan and elevation drawings of engine-generator set and other components specified.
- Design Calculations: Signed and sealed by a qualified professional engineer. Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
- Vibration Isolation Base Details: Signed and sealed by a qualified professional engineer. Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include base weights.

Wiring Diagrams: Power, signal, and control wiring.

Qualification Data: For installer, manufacturer, and testing agency.

Source quality-control test reports.

Certified summary of prototype-unit test report.
Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
Certified Summary of Performance Tests: Certify compliance with specified requirement to meet performance criteria for sensitive loads.
Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
Report of sound generation.
Report of exhaust emissions showing compliance with applicable regulations.
Certified Torsional Vibration Compatibility: Comply with NFPA 110.

Field quality-control test reports.

Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.

Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

Maintenance Proximity: Not more than four hours' normal travel time from Installer's place of business to Project site.
Engineering Responsibility: Preparation of data for vibration isolators and seismic restraints of engine skid mounts, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.

Manufacturer Qualifications: A qualified manufacturer. Maintain, within 200 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.

Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL), and that is acceptable to authorities having jurisdiction.

Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.

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.

Comply with ASME B15.1.

Comply with NFPA 37.

Comply with NFPA 70.

Comply with NFPA 99.

Comply with NFPA 110 requirements for Level 1 emergency power supply system.

Comply with UL 2200.

Engine Exhaust Emissions: Comply with applicable state and local government requirements.

Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

1.5 PROJECT CONDITIONS

Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

Ambient Temperature: Minus 15 to plus 40 deg C.
Relative Humidity: 0 to 95 percent.
Altitude: Sea level to 4400 feet.

1.6 COORDINATION

Coordinate size and location of concrete bases for package engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

Coordinate size and location of roof curbs, equipment supports, and roof penetrations for remote radiators. These items are specified in Division 07 Section "Roof Accessories."

1.7 WARRANTY

Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.

Warranty Period: Two years from date of Substantial Completion.

1.8 MAINTENANCE SERVICE

Initial Maintenance Service: Beginning at Substantial Completion, provide 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include quarterly exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

1.9 EXTRA MATERIALS

Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

Fuses: One for every 10 of each type and rating, but no fewer than one of each.
Indicator Lamps: Two for every six of each type used, but no fewer than two of each.
Filters: One set each of lubricating oil, fuel, and combustion-air filters.

PART 2 - PRODUCTS

2.0 MANUFACTURERS

Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

Manufacturers: Subject to compliance with requirements, provide products by one of the following:

Caterpillar; Engine Div.
Generac Power Systems, Inc.
Kohler Co.; Generator Division.
Onan/Cummins Power Generation; Industrial Business Group.

2.1 ENGINE-GENERATOR SET

Factory-assembled and -tested, engine-generator set.

Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.

Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and generator-set center of gravity.

Capacities and Characteristics:

Power Output Ratings: Nominal ratings as indicated.
Output Connections: Three-phase, four wire.
Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.

Generator-Set Performance:

Steady-State Voltage Operational Bandwidth: 3 percent of rated output voltage from no load to full load.

Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.
Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.
Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.
Start Time: Comply with NFPA 110, Type 10, system requirements.

Generator-Set Performance for Sensitive Loads:

Oversizing generator compared with the rated power output of the engine is permissible to meet specified performance.

Nameplate Data for Oversized Generator: Show ratings required by the Contract Documents rather than ratings that would normally be applied to generator size installed.

Steady-State Voltage Operational Bandwidth: 1 percent of rated output voltage from no load to full load.
Transient Voltage Performance: Not more than 10 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 0.5 second.
Steady-State Frequency Operational Bandwidth: Plus or minus 0.25 percent of rated frequency from no load to full load.
Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
Transient Frequency Performance: Less than 2-Hz variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within three seconds.
Output Waveform: At no load, harmonic content measured line to neutral shall not exceed 2 percent total with no slot ripple. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to winding insulation or other generator system components.
Excitation System: Performance shall be unaffected by voltage distortion caused by nonlinear load.

Provide permanent magnet excitation for power source to voltage regulator.

Start Time: Comply with NFPA 110, Type 10, system requirements.

2.2 ENGINE

Fuel: Natural gas.

Rated Engine Speed: 1800 rpm.

Maximum Piston Speed for Four-Cycle Engines: 2250 fpm.

Lubrication System: The following items are mounted on engine or skid:

Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

Engine Fuel System:

Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions.
Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.
Dual Natural Gas with LP-Gas Backup (Vapor-Withdrawal) System:

Carburetor.
Secondary Gas Regulators: One for each fuel type.
Fuel-Shutoff Solenoid Valves: One for each fuel source.
Flexible Fuel Connectors: One for each fuel source.

Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity.

Governor: Adjustable isochronous, with speed sensing.

Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set mounting frame and integral engine-driven coolant pump.

Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.

Rating: 50-psig maximum working pressure with coolant at 180 deg F, and noncollapsible under vacuum.
End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

Cooling System: Closed loop, liquid cooled, with remote radiator and integral engine-driven coolant pump.

Configuration: Horizontal air discharge.
Radiator Core Tubes: Nonferrous-metal construction other than aluminum.
Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
Fan: Driven by totally enclosed electric motor with sealed bearings.
Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.

Muffler/Silencer: Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.

Minimum sound attenuation of 25 dB at 500 Hz.
Sound level measured at a distance of 10 feet from exhaust discharge after installation is complete shall be 85 dBA or less.

Air-Intake Filter: Standard-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

Starting System: 12-V electric, with negative ground.

Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.
Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
Cranking Cycle: As required by NFPA 110 for system level specified.
Battery: Adequate capacity within ambient temperature range specified in Part 1 "Project Conditions" Article to provide specified cranking cycle at least twice without recharging.
Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 10 deg C regardless of external ambient temperature within range specified in Part 1 "Project Conditions" Article. Include accessories required to support and fasten batteries in place.
Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit shall comply with UL 1236 and include the following features:

Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg C to plus 60 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.
Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.

Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

2.3 CONTROL AND MONITORING

Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down generator set.

Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts generator set. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down generator set.

Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the generator set. Mounting method shall isolate the control panel from generator-set vibration.

Indicating and Protective Devices and Controls: As required by NFPA 110 for Level 1 system, and the following:

AC voltmeter.
AC ammeter.
AC frequency meter.
DC voltmeter (alternator battery charging).
Engine-coolant temperature gage.
Engine lubricating-oil pressure gage.
Running-time meter.
Ammeter-voltmeter, phase-selector switch(es).
Generator-voltage adjusting rheostat.
Fuel tank derangement alarm.
Fuel tank high-level shutdown of fuel supply alarm.
Generator overload.

Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.

Connection to Data Link: A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication is reserved for connections for data-link transmission of indications to remote data terminals. Data system connections to terminals are covered in Division 26 Section "Electrical Power Monitoring and Control."

Common Remote Audible Alarm: Comply with NFPA 110 requirements for Level 1 systems. Include necessary contacts and terminals in control and monitoring panel.

Overcrank shutdown.

Coolant low-temperature alarm.
Control switch not in auto position.
Battery-charger malfunction alarm.
Battery low-voltage alarm.

Common Remote Audible Alarm: Signal the occurrence of any events listed below without differentiating between event types. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset.

Engine high-temperature shutdown.
Lube-oil, low-pressure shutdown.
Overspeed shutdown.
Remote emergency-stop shutdown.
Engine high-temperature pre-alarm.
Lube-oil, low-pressure pre-alarm.
Fuel tank, low-fuel level.
Low coolant level.

Remote Alarm Annunciator: Comply with NFPA 99. An LED labeled with proper alarm conditions shall identify each alarm event and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.

Remote Emergency-Stop Switch: Flush; wall mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.

2.4 GENERATOR OVERCURRENT AND FAULT PROTECTION

Generator Circuit Breaker: Molded-case, electronic-trip type; 100 percent rated; complying with UL 489.

Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.
Trip Settings: Selected to coordinate with generator thermal damage curve.
Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
Mounting: Adjacent to or integrated with control and monitoring panel.

Generator Protector: Microprocessor-based unit shall continuously monitor current level in each phase of generator output, integrate generator heating effect over time, and predict when thermal damage of alternator will occur. When signaled by generator protector or other generator-set protective devices, a shunt-trip device in the generator disconnect switch shall open the switch to disconnect the generator from load circuits. Protector shall perform the following functions:

Initiates a generator overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other generator-set malfunction alarms.
Under single or three-phase fault conditions, regulates generator to 300 percent of rated full-load current for up to 10 seconds.
As overcurrent heating effect on the generator approaches the thermal damage point of the unit, protector switches the excitation system off, opens the generator disconnect device, and shuts down the generator set.
Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.

Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground-fault. Integrate ground-fault alarm indication with other generator-set alarm indications.

2.5 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

Comply with NEMA MG 1.

Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

Electrical Insulation: Class H or Class F.

Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.

Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

Enclosure: Dripproof.

Instrument Transformers: Mounted within generator enclosure.

Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.

Adjusting rheostat on control and monitoring panel shall provide plus or minus 5 percent adjustment of output-voltage operating band.

Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

Subtransient Reactance: 12 percent, maximum.

2.6 OUTDOOR GENERATOR-SET ENCLOSURE

Description: Vandal-resistant, weatherproof steel housing, wind resistant up to 100 mph. Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure.

Description: Prefabricated or preengineered walk-in enclosure with the following features:

Construction: Galvanized-steel, metal-clad, integral structural-steel-framed building erected on concrete foundation.
Structural Design and Anchorage: Comply with ASCE 7 for wind loads.
Space Heater: Thermostatically controlled and sized to prevent condensation.
Louvers: Equipped with bird screen and filter arranged to permit air circulation when engine is not running while excluding exterior dust, birds, and rodents.
Hinged Doors: With padlocking provisions.
Ventilation: Louvers equipped with bird screen and filter arranged to permit air circulation while excluding exterior dust, birds, and rodents.
Thermal Insulation: Manufacturer's standard materials and thickness selected in coordination with space heater to maintain winter interior temperature within operating limits required by engine-generator-set components.
Muffler Location: External to enclosure.

Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for 2 hours with ambient temperature at top of range specified in system service conditions.

Louvers: Fixed-engine, cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain and snow.
Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.

2.7 MOTORS

General requirements for motors are specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.

2.8 VIBRATION ISOLATION DEVICES

Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized-steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.

Material: Bridge-bearing neoprene, complying with AASHTO M 251.
Durometer Rating: 50.
Number of Layers: Two.

Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.

Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch-thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
Outside Spring Diameter: Not less than 80 percent of compressed height of the spring at rated load.
Minimum Additional Travel: 50 percent of required deflection at rated load.
Lateral Stiffness: More than 80 percent of rated vertical stiffness.
Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.9 FINISHES

Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

2.10 SOURCE QUALITY CONTROL

Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.

Tests: Comply with NFPA 110, Level 1 Energy Converters and with IEEE 115.

Project-Specific Equipment Tests: Before shipment, factory test engine-generator set and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:

Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
Full load run.
Maximum power.
Voltage regulation.
Transient and steady-state governing.
Single-step load pickup.
Safety shutdown.
Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.
Report factory test results within 10 days of completion of test.

PART 3 - EXECUTION

3.0 EXAMINATION

Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator performance.

Examine roughing-in of piping systems and electrical connections. Verify actual locations of connections before packaged engine-generator installation.

Proceed with installation only after unsatisfactory conditions have been corrected.

3.1 INSTALLATION

Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110.

Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.

Install packaged engine generator with restrained spring isolators having a minimum deflection of 1 inch on 4-inch-high concrete base.

Install Schedule 40, black steel piping with welded joints and connect to engine muffler. Install thimble at wall. Piping shall be same diameter as muffler outlet. Flexible connectors and steel piping materials and installation requirements are specified in Division 23 Section "Hydronic Piping."

Install condensate drain piping to muffler drain outlet full size of drain connection with a shutoff valve, stainless-steel flexible connector, and Schedule 40, black steel pipe with welded joints. Flexible connectors and piping materials and installation requirements are specified in Division 23 Section "Hydronic Piping."

Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.2 CONNECTIONS

Piping installation requirements are specified in Division 23 Sections. Drawings indicate general arrangement of piping and specialties.

Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.

Connect cooling-system water piping to engine-generator set and [remote radiator] [heat exchanger] with flexible connectors.

Connect engine exhaust pipe to engine with flexible connector.

Connect fuel piping to engines with a gate valve and union and flexible connector.

Diesel storage tanks, tank accessories, piping, valves, and specialties for fuel systems are specified in Division 23 Section "Facility Fuel-Oil Piping."
Natural-gas piping, valves, and specialties for gas distribution are specified in Division 23 Section "Facility Natural-Gas Piping."
LP-gas piping, valves, and specialties for gas piping are specified in Division 23 Section "Facility Liquefied-Petroleum Gas Piping."

Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 IDENTIFICATION

Identify system components according to Division 23 Section "Identification for HVAC Piping and Equipment" and Division 26 Section "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.

Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

Perform tests and inspections and prepare test reports.

Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

Tests and Inspections:

Perform tests recommended by manufacturer and each electrical test and visual and mechanical inspection for "AC Generators and for Emergency Systems" specified in NETA Acceptance Testing Specification. Certify compliance with test parameters.
NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, single-step full-load pickup test.
Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.

Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.

Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
Verify acceptance of charge for each element of the battery after discharge.
Verify that measurements are within manufacturer's specifications.

Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.
Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding 40-inch wg. Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.
Exhaust Emissions Test: Comply with applicable government test criteria.
Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases and verify that performance is as specified.
Harmonic-Content Tests: Measure harmonic content of output voltage under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within specified limits.
Noise Level Tests: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and discharge, at four locations on the property line, and compare measured levels with required values.

Coordinate tests with tests for transfer switches and run them concurrently.

Test instruments shall have been calibrated within the last 12 months, traceable to standards of NIST, and adequate for making positive observation of test results. Make calibration records available for examination on request.

Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

Remove and replace malfunctioning units and retest as specified above.

Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each power wiring termination and each bus connection. Remove all access panels so terminations and connections are accessible to portable scanner.

Follow-up Infrared Scanning: Perform an additional follow-up infrared scan 11 months after date of Substantial Completion.
Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

Record of Infrared Scanning: Prepare a certified report that identifies terminations and connections checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 DEMONSTRATION

Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 26 32 13

SECTION 26 36 00

TRANSFER SWITCHES

PART 1 - GENERAL

1.0 RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.1 SUMMARY

This Section includes transfer switches rated 600 V and less, including the following:

- Automatic transfer switches.
- Nonautomatic transfer switches.
- Remote annunciation systems.

1.2 SUBMITTALS

Product Data: For each type of product indicated. Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.

Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.

- Single-Line Diagram: Show connections between transfer switch, bypass/isolation switch, power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch.

Qualification Data: For manufacturer and testing agency.

Field quality-control test reports.

Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

- Features and operating sequences, both automatic and manual.
- List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.3 QUALITY ASSURANCE

Manufacturer Qualifications: Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than eight hours from time of notification.

Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

Source Limitations: Obtain automatic transfer switches, nonautomatic transfer switches, and remote annunciators through one source from a single manufacturer.

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.

Comply with NEMA ICS 1.

Comply with NFPA 70.

Comply with NFPA 110.

Comply with UL 1008 unless requirements of these Specifications are stricter.

1.4 COORDINATION

Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

PART 2 - PRODUCTS

2.0 MANUFACTURERS

Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

Manufacturers: Subject to compliance with requirements, provide products by one of the following:

Contactor Transfer Switches:

AC Data Systems, Inc.
Caterpillar; Engine Div.
Emerson; ASCO Power Technologies, LP.
Generac Power Systems, Inc.
GE Zenith Controls.
Kohler Power Systems; Generator Division.
Onan/Cummins Power Generation; Industrial Business Group.
Russelectric, Inc.
Spectrum Detroit Diesel.

2.1 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.

Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.

Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.

Solid-State Controls: Repetitive accuracy of all settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.

Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.

Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are not acceptable.
Switch Action: Double throw; mechanically held in both directions.
Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts.

Neutral Terminal: Solid and fully rated, unless otherwise indicated.

Oversize Neutral: Ampacity and switch rating of neutral path through units indicated for oversize neutral shall be double the nominal rating of circuit in which switch is installed.

Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device.

Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, either by color-code or by numbered or lettered wire and cable tape markers at terminations. Color-coding and wire and cable tape markers are specified in Division 26 Section "Identification for Electrical Systems."

Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
Control Wiring: Equipped with lugs suitable for connection to terminal strips.

Enclosures: General-purpose NEMA 250, Type 1, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

2.2 AUTOMATIC TRANSFER SWITCHES

Comply with Level 1 equipment according to NFPA 110.

Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.

Manual Switch Operation: Under load, with door closed and with either or both sources energized. Transfer time is same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.

Manual Switch Operation: Unloaded. Control circuit automatically disconnects from electrical operator during manual operation.

Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval is adjustable from 1 to 30 seconds.

Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.

Transfer Switches Based on Molded-Case-Switch Components: Comply with NEMA AB 1, UL 489, and UL 869A.

In-Phase Monitor: Factory-wired, internal relay controls transfer so it occurs only when the two sources are synchronized in phase. Relay compares phase relationship and frequency difference between normal and emergency sources and initiates transfer when both sources are within 15 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer is initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage.

Motor Disconnect and Timing Relay: Controls designate starters so they disconnect motors before transfer and reconnect them selectively at an adjustable time interval after transfer. Control connection to motor starters is through wiring external to automatic transfer switch. Time delay for reconnecting individual motor loads is adjustable between 1 and 60 seconds, and settings are as indicated. Relay contacts handling motor-control circuit inrush and seal currents are rated for actual currents to be encountered.

Programmed Neutral Switch Position: Switch operator has a programmed neutral position arranged to provide a midpoint between the two working switch positions, with an intentional, time-controlled pause at midpoint during transfer. Pause is adjustable from 0.5 to 30 seconds minimum and factory set for 0.5 second, unless otherwise indicated. Time delay occurs for both transfer directions. Pause is disabled unless both sources are live.

Automatic Transfer-Switch Features:

Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.

Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.

Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.

Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes to automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.

Test Switch: Simulate normal-source failure.

Switch-Position Pilot Lights: Indicate source to which load is connected.

Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.

Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."

Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
Engine Shutdown Contacts: Instantaneous; shall initiate shutdown sequence at remote engine-generator controls after retransfer of load to normal source.
Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:

Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
Push-button programming control with digital display of settings.
Integral battery operation of time switch when normal control power is not available.

2.3 NONAUTOMATIC TRANSFER SWITCHES

Operation: Electrically actuated by push buttons designated "Normal Source" and "Alternate Source." Switch shall be capable of transferring load in either direction with either or both sources energized.

Operation: Electrically actuated by push buttons designated "Normal Source" and "Alternate Source." In addition, removable manual handle provides quick-make, quick-break manual-switching action. Switch shall be capable of electrically or manually transferring load in either direction with either or both sources energized. Control circuit disconnects from electrical operator during manual operation.

Double-Throw Switching Arrangement: Incapable of pauses or intermediate position stops during switching sequence.

Nonautomatic Transfer-Switch Accessories:

Pilot Lights: Indicate source to which load is connected.
Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and alternate-source sensing circuits.

Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
Emergency Power Supervision: Red light with nameplate engraved "Alternate Source Available."

Unassigned Auxiliary Contacts: One set of normally closed contacts for each switch position, rated 10 A at 240-V ac.

2.4 REMOTE ANNUNCIATOR SYSTEM

Functional Description: Remote annunciator panel shall annunciate conditions for indicated transfer switches. Annunciation shall include the following:

Sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
Switch position.
Switch in test mode.
Failure of communication link.

Annunciator Panel: LED-lamp type with audible signal and silencing switch.

Indicating Lights: Grouped for each transfer switch monitored.
Label each group, indicating transfer switch it monitors, location of switch, and identity of load it serves.
Mounting: Flush, modular, steel cabinet, unless otherwise indicated.
Lamp Test: Push-to-test or lamp-test switch on front panel.

2.5 SOURCE QUALITY CONTROL

Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

PART 3 - EXECUTION

3.0 INSTALLATION

Floor-Mounting Switch: Anchor to floor by bolting.

Concrete Bases: 4 inches high, reinforced, with chamfered edges. Extend base no more than 4 inches in all directions beyond the maximum dimensions of switch, unless otherwise indicated or unless required for seismic support. Construct concrete bases according to Division 26 Section "Hangers and Supports for Electrical Systems."

Annunciator and Control Panel Mounting: Flush in wall, unless otherwise indicated.

Identify components according to Division 26 Section "Identification for Electrical Systems."

Set field-adjustable intervals and delays, relays, and engine exerciser clock.

3.1 CONNECTIONS

Wiring to Remote Components: Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.2 FIELD QUALITY CONTROL

Testing Agency: Engage a qualified independent testing and inspecting agency to perform tests and inspections and prepare test reports.

Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

Perform tests and inspections and prepare test reports.

Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installation, including connections, and to assist in testing.
After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.

Check for electrical continuity of circuits and for short circuits.
Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
Verify that manual transfer warnings are properly placed.
Perform manual transfer operation.

After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.

Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
Simulate loss of phase-to-ground voltage for each phase of normal source.
Verify time-delay settings.
Verify pickup and dropout voltages by data readout or inspection of control settings.
Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for 1 pole deviating by more than 50 percent from other poles.
Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.

Verify grounding connections and locations and ratings of sensors.

Testing Agency's Tests and Inspections:

After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.

Check for electrical continuity of circuits and for short circuits.
Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
Verify that manual transfer warnings are properly placed.
Perform manual transfer operation.

After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.

Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
Simulate loss of phase-to-ground voltage for each phase of normal source.
Verify time-delay settings.
Verify pickup and dropout voltages by data readout or inspection of control settings.
Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for 1 pole deviating by more than 50 percent from other poles.
Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.

Verify grounding connections and locations and ratings of sensors.

Coordinate tests with tests of generator and run them concurrently.

Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

Remove and replace malfunctioning units and retest as specified above.

Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.

Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.
Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.3 DEMONSTRATION

Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below. Refer to Division 01 Section "Demonstration and Training."

Coordinate this training with that for generator equipment.

END OF SECTION 26 36 00

SECTION 26 43 13

SURGE PROTECTION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

1.0 RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.1 SUMMARY

Section includes field-mounted SPDs for low-voltage (120 to 600 V) power distribution and control equipment.

Related Requirements:

Section 26 24 16 "Panelboards" for factory-installed SPDs.

1.2 DEFINITIONS

Inominal: Nominal discharge current.

MCOV: Maximum continuous operating voltage.

Mode(s), also Modes of Protection: The pair of electrical connections where the VPR applies.

MOV: Metal-oxide varistor; an electronic component with a significant non-ohmic current-voltage characteristic.

OCPD: Overcurrent protective device.

SCCR: Short-circuit current rating.

SPD: Surge protective device.

VPR: Voltage protection rating.

1.3 ACTION SUBMITTALS

Product Data: For each type of product.

Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
Copy of UL Category Code VZCA certification, as a minimum, listing the tested values for VPRs, Inominal ratings, MCOVs, type designations, OCPD requirements, model numbers, system voltages, and modes of protection.

1.4 INFORMATIONAL SUBMITTALS

Field quality-control reports.

Sample Warranty: For manufacturer's special warranty.

1.5 CLOSEOUT SUBMITTALS

Maintenance Data: For SPDs to include in maintenance manuals.

1.6 WARRANTY

Manufacturer's Warranty: Manufacturer agrees to replace or replace SPDs that fail in materials or workmanship within specified warranty period.

Warranty Period: Ten years from date of Substantial Completion.

PART 2 - PRODUCTS

2.0 GENERAL SPD REQUIREMENTS

SPD with Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

Comply with NFPA 70.

Comply with UL 1449.

MCOV of the SPD shall be less than 115% for 480Y/277V and 125% for 208Y/120V nominal RMS system voltages.

2.1 SERVICE ENTRANCE SUPPRESSOR

Manufacturers: Subject to compliance with requirements, provide products by one of the following:

Current Technology, Inc.
Eaton Corporation.
General Electric Company.
Liebert Corporation; a division of Emerson.
Siemens Energy & Automation, Inc.
Square D; Schneider Electric.

SPDs: Comply with UL 1449, Type 2.

SPDs with the following features and accessories:

Integral disconnect switch.
Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
Indicator light display for protection status.
Form-C contacts rated at, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
Surge counter.

Comply with UL 1283.

Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 240kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.

Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V, three-phase, four-wire circuits shall not exceed the following:

Line to Neutral: 1200 V for 480Y/277 V.

Line to Ground: 1200 V for 480Y/277 V.
Line to Line: 2000 V for 480Y/277 V.

SCCR: Equal or exceed 200 kA.

Inominal Rating: 20 kA.

2.2 ENCLOSURES

Indoor Enclosures: NEMA 250, Type 1.

Outdoor Enclosures: NEMA 250, Type 3R.

2.3 CONDUCTORS AND CABLES

Power Wiring: Same size as SPD leads, complying with Section 26 05 19 "Building Wire and Cable."

Class 2 Control Cables: Multiconductor cable with copper conductors not smaller than No. 18 AWG, complying with Section 26 05 19 "Building Wire and Cable."

Class 1 Control Cables: Multiconductor cable with copper conductors not smaller than No. 14 AWG, complying with Section 26 05 19 "Building Wire and Cable."

PART 3 - EXECUTION

3.0 INSTALLATION

Comply with NECA 1.

Install an OCPD or disconnect as required to comply with the UL listing of the SPD.

Install SPDs with conductors between suppressor and points of attachment as short and straight as possible and adjust circuit-breaker positions to achieve shortest and straightest leads. Do not splice and extend SPD leads unless specifically permitted by manufacturer. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.

Use crimped connectors and splices only. Wire nuts are unacceptable.

Wiring:

Power Wiring: Comply with wiring methods in Section 26 05 19 "Building Wire and Cable."
Controls: Comply with wiring methods in Section 26 05 19 "Building Wire and Cable."

3.1 FIELD QUALITY CONTROL

Perform the following tests and inspections with the assistance of a factory-authorized service representative.

Compare equipment nameplate data for compliance with Drawings and Specifications.
Inspect anchorage, alignment, grounding, and clearances.
Verify that electrical wiring installation complies with manufacturer's written installation requirements.

An SPD will be considered defective if it does not pass tests and inspections.

Prepare test and inspection reports.

3.2 STARTUP SERVICE

Complete startup checks according to manufacturer's written instructions.

Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests, and reconnect them immediately after the testing is over.

Energize SPDs after power system has been energized, stabilized, and tested.

3.3 DEMONSTRATION

Train Owner's maintenance personnel to operate and maintain SPDs.

END OF SECTION 26 43 13

SECTION 26 51 00
INTERIOR LIGHTING

PART 1 - GENERAL

1.0 SUMMARY

Section Includes:

- Interior luminaires, sources, drivers, and accessories.
- Exit signs.
- Luminaire supports.

1.1 DEFINITIONS

BF: Ballast factor.

CCT: Correlated color temperature.

CRI: Color-rendering index.

CU: Coefficient of utilization.

ESD: Electrostatic discharge.

EMI: Electromagnetic Interference.

Fixture (Lighting): See "Luminaire."

HID: High-intensity discharge.

IP Rating: International Protection or Ingress Protection Rating.

LED: Light-emitting diode.

LER: Luminaire efficacy rating.

Lumen: Measured light output of source or luminaire.

Luminaire: Complete assembly, including source, driver, reflector, lens, and housing.

RCR: Room cavity ratio.

Source (Electric Light): Lamp, bulb, LED module, or other device used to create artificial light. Major families include: LED (SSL).

SSL: Solid State Lighting (Typically LED type).

1.2 SUBMITTALS

Product Data:

Luminaires: For each type of luminaire, arranged in order of luminaire type designation indicated on luminaire schedule. Include manufacturer's specification sheet with ordering guide completed for specified or required model number selections. Specification sheet or additional manufacturer's data sheets shall include features, support components, accessories, finishes, and the following:

Physical description of luminaire including materials and dimensions.
Details of installation and construction.
Source ANSI and manufacturer's model number with specifications including life, lumen output, CCT, CRI, and energy-efficiency data.
LED driver manufacturer's model number and specifications.

Shop Drawings: Show details of linear and custom luminaires for specific luminaire types and layouts indicated on Drawings. Indicate dimensions, weights, methods of field assembly, components, features, and accessories.

Wiring Diagrams: Power and control wiring.
Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
For continuous linear luminaires, including recessed, pendant, and surface mounted, provide manufacturer's drawings showing components for each continuous length, including but not limited to power feed and control wiring locations, staggered lamping (if applicable), lens breaks, corners/connectors, and mounting and suspension points with attachment details. Also include any separate switching zones on these drawings. Drawings shall be provided for each specific luminaire installation on the floor plan and the submittal shall contain a floor plan keying the manufacturer's drawings with the floor plan.

Qualification Data: For testing laboratory providing photometric data for luminaires.

1.3 SUBSTITUTIONS AND ALTERNATES

Substitutions and alternates for luminaires and retrofit kits shall be in accordance with Division 1 and Division 26 Section "Basic Electrical Requirements."

Calculations: Manufacturer shall perform point to point calculations for proposed luminaire(s). Calculations shall utilize light loss factors and reflectances provided by the Engineer. Provide .ies file for proposed luminaire to Engineer upon request, file shall include all accessories. Photometric data which does not accurately reflect the proposed luminaire will not be accepted.

1.4 BIDDING

Manufacturers listed in the luminaire schedule shall be assumed capable of supplying the listed fixtures, including all accessories, unless exceptions are set forth in their quotations. Any such exceptions shall immediately be brought to the attention of the Architect and Engineer for resolution. Such resolution may involve changing the specification of one or more luminaire and time shall be afforded for this process.

1.5 QUALITY ASSURANCE

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.

FCC EMI Regulation: Electronic Devices such as LED drivers shall comply with the Federal Communication Commission (FCC) Code of Federal Regulations 47 CFR 15 for conducted and radiated emissions for commercial environments (Class A).

Comply with IEEE C2, "National Electrical Safety Code."

Comply with NFPA 70.

Comply with NEMA 410 - Performance Testing for Lighting Controls and Switching Devices with Electronic Drivers.

Each LED luminaire type shall be tested in compliance with IES Standard LM79 & LM80 and binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

1.6 COORDINATION

Coordinate layout and installation of luminaires and suspension system with other trades as required for preparation of Coordination Drawings.

Sequence installation of the lighting to minimize the possibility of damage and soiling during the remainder of construction.

Coordinate luminaire types with ceiling construction.

Prior to submittals, coordinate drivers compatible with the lighting controls to be installed.

Prior to submittals, coordinate recessed luminaire grid, flange, or trim assembly with architectural ceiling system specified and ceiling assembly submittals accepted for installation.

1.7 DELIVERY, STORAGE, AND HANDLING

Protect finishes of exposed surfaces by applying a strippable temporary or other suitable protective covering before shipping.

1.8 WARRANTY

Special Warranty for Drivers: Manufacturer's standard form in which manufacturer agrees to repair or replace drivers that fail in materials or workmanship within specified warranty period.

Warranty Period for Drivers: Five years from date of Substantial Completion.

Special Warranty for LED modules and/or luminaires: Manufacturer’s standard form, made out to Owner and signed by LED module and/or luminaire manufacturer agreeing to replace modules and/or luminaires that fail in materials or workmanship, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.

Warranty Period: Five year(s) from date of Substantial Completion.

1.9 EXTRA MATERIALS

Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. A typewritten list, including quantities, of all extra materials provided shall be included in the operations and maintenance manual.

Glass and Plastic Lenses, Covers, and Other Optical Parts: 1 for every 100 of each type and rating installed. Furnish at least one of each type.

Drivers: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
Globes and Guards: 1 for every 20 of each type and rating installed. Furnish at least one of each type.
LED Modules: 1 for every 100 of each type and rating installed. Furnish at least one of each type.

PART 2 - PRODUCTS

2.0 MANUFACTURERS

Luminaire Manufacturers: Subject to compliance with requirements, provide product indicated on luminaire schedule. Luminaire manufacturer listed first, or a single manufacturer listed, for a luminaire type on luminaire schedule shall be considered as the basis of design product. Contractor is responsible for provision of product and performance equal to basis of design for other manufacturers listed for each luminaire type.

LED Manufacturers: Provide products by one of the following:

Philips Lumiled
Nichia
CREE

LED Driver Manufacturers: Provide products by luminaire Manufacturer compatible with LED module.

2.1 LUMINAIRES AND COMPONENTS, GENERAL REQUIREMENTS

Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.

Factory-Applied Labels: Comply with UL 1598. Include recommended source(s). Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when source(s) are in place.

Label shall include the following source characteristics:

"USE ONLY" and include specific source type.
Source diameter, shape, size, wattage, and coating
CCT and CRI.

Recessed Luminaires: Comply with NEMA LE 4 for ceiling compatibility for recessed luminaires. Where Target Efficacy Rating (TER) is specified, for commercial downlights, test according to NEMA LE 6.

LED Luminaires: Comply with UL 1598. Where Target Efficacy Rating (TER) is specified, test according to NEMA LE 6.

Materials

Metal Parts:

Free of burrs and sharp corners and edges.
Sheet Metal Components: Steel, unless otherwise indicated.

Form and support to prevent warping and sagging.

Steel:

ASTM A 36/A 36M for carbon structural steel.
ASTM A 568/A 568M for sheet steel.

Stainless Steel:

Manufacturer's standard grade.
Manufacturer's standard type, ASTM A 240/240 M.

Galvanized Steel: ASTM A 653/A 653 M.
Aluminum: ASTM B 209.

Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit replacement of source without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during replacement of source and when secured in operating position.

Plastic and Glass Diffusers, Covers, and Globes:

Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

Lens Thickness: At least 0.125 inch minimum unless different thickness is indicated.
UV stabilized.

Glass: Annealed crystal glass, unless otherwise indicated.

Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of support materials. Variations in finishes are unacceptable in the same luminaire or type of luminaire.

2.2 LED MODULES

Correlated Color Temperature: As indicated on luminaire schedule.

Color Rendering Index: Minimum CRI of 80.

Minimum Lifespan: 50,000 hours while retaining 70% of lumen output. The lifespan hours indicated are permitted to be determined by projecting long term lumen maintenance of the LED source per IES TM-21 and testing methods per IES LM-80 for a rated lumen maintenance life of L70.

Binning: LED's shall be binned according to NEMA standard SSL 3-2010.

Replacement: LED module shall be replaceable independent of the luminaire housing.

Dimming: Ensure compatibility between dimming switch and/or dimming control system and LED driver. LED's shall dim from 100-percent to value specified on luminaire schedule for each luminaire type.

2.3 LED DRIVERS

General Requirements:

Operate for at least 50,000 hours at maximum case temperature and 90 percent non-condensing relative humidity.
Provide thermal fold-back protection by automatically reducing power output (dimming) to protect LED driver and LED light engine/fixture from damage due to over-temperature conditions that approach or exceed the LED driver's maximum operating temperature at calibration point.
Provide integral recording of operating hours and maximum operating temperature to aid in troubleshooting and warranty claims.
Designed and tested to withstand ESD without impairment when tested according to IEC 61000-4-2.
Manufactured in a facility that employs ESD reduction practices in compliance with ANSI/ESD S20.20.
UL 8750 recognized or listed as applicable.
UL Type TL rated or UL Class P listed where possible to allow for easier fixture evaluation and listing of different driver series.
Suitable for field replacement as applicable; listed in accordance with UL 1598C or UL 8750, Class P as indicated.
Designed and tested to withstand Category A surges of 4,000 V according to IEEE C62.41.2 without impairment of performance.
Class A sound rating; Inaudible in a 27 dBA ambient.
Demonstrate no visible change in light output with a variation of plus or minus 10 percent change in line-voltage input.
Total Harmonic Distortion (THD) of less than 10%
Power Factor equal to or greater than 0.90.
LED drivers of the same family/series to track evenly across multiple fixtures at all light levels.
Meet NEMA 410 inrush requirements for mitigating inrush currents with solid state lighting sources.
Employ integral fault protection up to 277 V to prevent LED driver damage or failure in the event of incorrect application of line-voltage to communication link inputs.

2.4 EXIT SIGNS

Description: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

Internally Lighted Signs:

Sources for AC Operation: LEDs, 70,000 hours minimum rated source life.

Battery: Sealed, maintenance-free, nickel-cadmium type.
Charger: Fully automatic, solid-state type with sealed transfer relay.
Operation: Relay automatically energizes source from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects sources from battery, and battery is automatically recharged and floated on charger.
Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

2.5 LUMINAIRE SUPPORT COMPONENTS

Comply with Division 26 Section "Supporting Devices and Seals" for channel- and angle-iron supports and nonmetallic channel and angle supports.

Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.

Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single luminaire. Finish same as luminaire.

Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gauge.

Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

PART 3 - EXECUTION

3.0 INSTALLATION

Luminaires: Set level, plumb, and square with ceilings and walls. Install sources in each luminaire.

Support for Luminaires in or on Grid-Type Suspended Ceilings: Use grid as a support element.

Install a minimum of four ceiling support system rods or wires for each luminaire. Locate not more than 6 inches from luminaire corners.
Support Clips: Fasten to luminaires and to ceiling grid members at or near each luminaire corner with clips that are UL listed for the application.
Luminaires of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support luminaires independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.
Install a minimum of two independent support rods or wires from structure to tabs on luminaire. Wire or rod shall have breaking strength of the weight of luminaire at a safety factor of 3.
Luminaires of weight greater than 56 pounds-force, or lesser weight per the authority having jurisdiction, shall be supported from structure with approved hangers.
Connection devices at structure for support of wires, rods, or other approved hangers shall withstand a minimum weight of 100 pounds-force, or greater weight per the authority having jurisdiction.

Suspended Luminaire Support:

Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers.
Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of luminaire chassis, including one at each end.
Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

Adjust luminaires that require field adjustment or aiming as indicated on Drawings in the presence of Engineer. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources.

Protect installed luminaires from damage during the remainder of the construction period.

Clean lighting of dirt and construction debris upon completion of construction activities, prior to final acceptance by owner. Clean fingerprints and smudges from lenses and reflectors.

Replace any burnt out sources and non-working luminaire components prior to final acceptance by owner.

Connect wiring according to Division 26 Section "Building Wire and Cable."

Install remote drivers in accessible location as indicated or as required for complete installation, using conductors per manufacturer's recommendations and not exceeding manufacturer's recommended maximum conductor length to luminaire.

3.1 FIELD QUALITY CONTROL

Inspect each installed luminaire for damage. Replace damaged luminaires and components.

Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.

Verify operation of photoelectric controls.

Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to emergency and retransfer to normal.

Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION 26 51 00

SECTION 26 50 00
EXTERIOR LIGHTING

PART 1 - GENERAL

1.0 SUMMARY

Section Includes:

Exterior luminaires, sources, drivers, and accessories.
Luminaire-mounted photoelectric relays.
Poles and accessories.

1.1 DEFINITIONS

BF: Ballast factor

CCT: Correlated color temperature.

CRI: Color-rendering index.

CU: Coefficient of utilization.

Fixture (Lighting): See "Luminaire."

HID: High-intensity discharge.

IP Rating: International Protection or Ingress Protection Rating.

LED: Light-emitting diode.

LER: Luminaire efficacy rating.

Lumen: Measured light output of source or luminaire.

Luminaire: Complete assembly, including source, driver, reflector, lens, and housing.

Pole: Luminaire support structure, including tower used for large area illumination.

Source (Electric Light): Lamp, bulb, LED module, or other device used to create artificial light. Major families include: Incandescent (filament), Fluorescent, HID, and LED (SSL).

SSL: Solid State Lighting (Typically LED type).

Standard: Same definition as "Pole" above.

1.2 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

Dead Load: Weight of luminaire and its horizontal and vertical supports, and supporting structure, applied as stated in AASHTO LTS-6.

Live Load: As stated in AASHTO LTS-6.

Ice Load: As stated in AASHTO LTS-6.

Wind Load: Pressure of wind on pole and luminaire, calculated and applied as stated in AASHTO LTS-6. Wind velocities shall be determined per AASHTO LTS-6 wind map. Should the job site fall near or between two wind zones, the higher velocity shall be used. In “Special Wind Regions” as identified on such wind map, the authority having jurisdiction shall be consulted for wind velocity data.

Wind speed for calculating wind load for poles 50 feet or less in height is as stated in AASHTO LTS-6.

1.3 SUBMITTALS

Product Data:

Luminaires: For each type of luminaire, arranged in order of luminaire type designation indicated on luminaire schedule. Include manufacturer’s specification sheet with ordering guide completed for specified or required model number selections. Specification sheet or additional manufacturer’s data sheet shall include features, pole, support components, accessories, finishes, and the following:

Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
Details of attaching luminaires and accessories.
Details of installation and construction.
Source ANSI and manufacturer’s model number with specifications including life, lumen output, CCT, CRI, and energy-efficiency data.
LED driver manufacturer’s model number and specifications.
Photometric data, in IESNA test report format and electronic transfer file format, based on laboratory tests complying with the currently adopted applicable IESNA standards.

Photometric data certified by a manufacturer's laboratory shall have current accreditation under the National Voluntary Laboratory Accreditation Program (NVLAP) for Energy Efficient Lighting Products.

Luminaire mounted photoelectric relays.
Materials, dimensions, and finishes of poles.
Anchor bolts for poles.

Shop Drawings: Show details for the following:

Nonstandard or Custom Luminaires: For such luminaries identified on Drawings.

Indicate dimensions, weights, methods of field assembly, components, features, and accessories.
Wiring Diagrams: Power and control wiring.

Anchor-bolt templates keyed to specific poles and certified by manufacturer.

Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS-6 and that load imposed by luminaire has been included in design.

Qualification Data: For testing laboratory providing photometric data for luminaires.

1.4 SUBSTITUTIONS AND ALTERNATES

Substitutions and alternates for luminaires shall be in accordance with Division 1 and Division 26 Section "Basic Electrical Requirements."

Calculations: Manufacturer shall perform point to point calculations for proposed luminaire(s). Calculations shall utilize light loss factors provided by the Engineer. Provide .ies file for proposed luminaire to Engineer upon request, file shall include all accessories. Photometric data which does not accurately reflect the proposed luminaire will not be accepted.

1.5 BIDDING

Manufacturers listed in the luminaire schedule shall be assumed capable of supplying the listed fixtures, including all accessories, unless exceptions are set forth in their quotations. Any such exceptions shall immediately be brought to the attention of the Architect and Engineer for resolution. Such resolution may involve changing the specification of one or more luminaire and time shall be afforded for this process.

1.6 QUALITY ASSURANCE

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.

Comply with IEEE C2, "National Electrical Safety Code."

Comply with NFPA 70.

Each LED luminaire type shall be tested in compliance with IES Standard LM79 & LM80 and binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

1.7 COORDINATION

Coordinate layout and installation of luminaires, poles, and foundations with other exterior construction, including but not limited to underground utilities, landscaping, and hardscaping.

Sequence installation of the lighting to minimize the possibility of damage and soiling during the remainder of construction.

Coordinate the work to provide drivers compatible with the lighting controls to be installed.

1.8 DELIVERY, STORAGE, AND HANDLING

Store poles on decay-resistant-treated skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

Package aluminum poles for shipping according to ASTM B 660.

Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

Protect finishes of exposed surfaces of luminaires by applying a strippable temporary or other suitable protective covering before shipping.

1.9 FIELD CONDITIONS

Verify existing and proposed utility structures prior to the start of work associated with luminaire installation.

Mark locations of exterior luminaires for approval by Architect prior to the start of luminaire installation.

1.10 WARRANTY

Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.

Warranty Period for Luminaires: Five years from date of Substantial Completion.
Warranty Period for Metal Corrosion: Five years from date of Substantial Completion.
Warranty Period for Color Retention: Five years from date of Substantial Completion.
Warranty Period for Drivers: Five years from date of Substantial Completion.
Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than three years from date of Substantial Completion.
Warranty Period for LED Modules and/or Luminaires: Five years from date of Substantial Completion.

1.11 EXTRA MATERIALS

Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. A typewritten list, including quantities, of all extra materials provided shall be included in the operations and maintenance manual.

Glass and Plastic Lenses, Covers, and Other Optical Parts: 1 for every 10 of each type and rating installed. Furnish at least one of each type.
Drivers: 1 for every 10 of each type and rating installed. Furnish at least one of each type.
Globes and Guards: 1 for every 10 of each type and rating installed. Furnish at least one of each type.
LED Modules: 1 for every 20 of each type and rating installed. Furnish at least one of each type.

PART 2 - PRODUCTS

2.0 MANUFACTURERS

Luminaire Manufacturers: Subject to compliance with requirements, provide product indicated on luminaire schedule. Luminaire manufacturer listed first, or a single manufacturer listed, for a luminaire type on luminaire schedule shall be considered as the basis of design product. Contractor is responsible for provision of product and performance equal to basis of design for other manufacturers listed for each luminaire type.

LED Manufacturers: Provide products by one of the following:

Philips Lumiled
Nichia
CREE

LED Driver Manufacturers: Provide products by luminaire Manufacturer compatible with LED module.

2.1 LUMINAIRES AND COMPONENTS, GENERAL REQUIREMENTS

Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.

Factory-Applied Labels: Comply with UL 1598. Include recommended source(s). Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when source(s) are in place.

Label shall include the following source characteristics:

"USE ONLY" and include specific source type.
Source diameter, shape, size, wattage, and coating
CCT and CRI.

Recessed Luminaires: Comply with NEMA LE 4 for ceiling compatibility for recessed luminaires. Where Target Efficacy Rating (TER) is specified, for commercial downlights, test according to NEMA LE 6.

LED Luminaires: Comply with UL 1598. Where Target Efficacy Rating (TER) is specified, test according to NEMA LE 6.

Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.

Metal Parts: Free of burrs and sharp corners and edges.

Sheet Metal Components: Corrosion-resistant aluminum, unless otherwise indicated. Form and support to prevent warping and sagging.

Plastic and Glass Diffusers, Covers, and Globes:

Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

Lens Thickness: At least 0.125 inch minimum unless different thickness is indicated.
UV stabilized.

Glass: Annealed crystal glass, unless otherwise indicated.

Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.

Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit replacement of source without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during replacement of source and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.

Exposed Hardware Material: Stainless steel.

Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.

Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:

White Surfaces: 85 percent.
Specular Surfaces: 83 percent.
Diffusing Specular Surfaces: 75 percent.

Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials. Variations in finishes are unacceptable in the same luminaire or type of luminaire.

Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

Color: As selected by Architect from manufacturer's full range.

Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.

Color: As selected by Architect from manufacturer's full range.

2.2 LUMINAIRE-MOUNTED PHOTOELECTRIC RELAYS

Comply with UL 773 or UL 773A.

Contact Relays: Factory mounted, single throw, designed to fail in the on position, and factory set to turn light unit on at 1.5 to 3 fc and off at 4.5 to 10 fc with 15-second minimum time delay. Relay shall have directional lens in front of photocell to prevent artificial light sources from causing false turnoff.

Relay with locking-type receptacle shall comply with NEMA C136.10.
Adjustable window slide for adjusting on-off set points.

2.3 LED MODULES

Correlated Color Temperature: As indicated on luminaire schedule.

Color Rendering Index: Minimum CRI of 75.

Minimum Lifespan: 50,000 hours while retaining 70% of lumen output. The lifespan hours indicated are permitted to be determined by projecting long term lumen maintenance of the LED source per IES TM-21 and testing methods per IES LM-80 for a rated lumen maintenance life of L70.

Binning: LED's shall be binned according to NEMA standard SSL 3-2010.

Replacement: LED module shall be replaceable independent of the luminaire housing.

Dimming: Ensure compatibility between dimming switch and/or dimming control system and LED driver. LED's shall dim from 100-percent to value specified on luminaire schedule for each luminaire type.

2.4 LED DRIVERS

General Requirements:

Operate for at least 50,000 hours at maximum case temperature and 90 percent non-condensing relative humidity.
Provide thermal fold-back protection by automatically reducing power output (dimming) to protect LED driver and LED light engine/fixture from damage due to over-temperature conditions that approach or exceed the LED driver's maximum operating temperature at calibration point.
Provide integral recording of operating hours and maximum operating temperature to aid in troubleshooting and warranty claims.
Designed and tested to withstand ESD without impairment when tested according to IEC 61000-4-2.
Manufactured in a facility that employs ESD reduction practices in compliance with ANSI/ESD S20.20.
UL 8750 recognized or listed as applicable.
UL Type TL rated or UL Class P listed where possible to allow for easier fixture evaluation and listing of different driver series.
Suitable for field replacement as applicable; listed in accordance with UL 1598C or UL 8750, Class P as indicated.
Designed and tested to withstand Category A surges of 4,000 V according to IEEE C62.41.2 without impairment of performance.
Class A sound rating; Inaudible in a 27 dBA ambient.
Demonstrate no visible change in light output with a variation of plus or minus 10 percent change in line-voltage input.
Total Harmonic Distortion (THD) of less than 10%
Power Factor equal to or greater than 0.90.
LED drivers of the same family/series to track evenly across multiple fixtures at all light levels.

Meet NEMA 410 inrush requirements for mitigating inrush currents with solid state lighting sources.
Employ integral fault protection up to 277 V to prevent LED driver damage or failure in the event of incorrect application of line-voltage to communication link inputs.

2.5 POLES AND SUPPORT COMPONENTS, GENERAL REQUIREMENTS

Structural Characteristics: Comply with AASHTO LTS-4.

Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in Part 1 "Structural Analysis Criteria for Pole Selection" Article, with a gust factor of 1.3.
Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.

Coordinate Pole Base Detail with Civil and Structural Engineer.

Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts, unless otherwise indicated.

Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.

Materials: Shall not cause galvanic action at contact points.
Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication, unless stainless-steel items are indicated.
Anchor-Bolt Template: Plywood or steel.

Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete."

Power-Installed Screw Foundations: Factory fabricated by pole manufacturer, with structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A 123/A 123M; and with top-plate and mounting bolts to match pole base flange and strength required to support pole, luminaire, and accessories.

Breakaway Supports: Frangible breakaway supports, tested by an independent testing agency acceptable to authorities having jurisdiction, according to AASHTO LTS-4.

2.6 STEEL POLES

Poles: Comply with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig; 1-piece construction up to 40 feet in height with access handhole in pole wall.

Shape: As specified on Drawings.
Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

Brackets for Luminaires: Detachable, cantilever, without underbrace.

Adapter fitting welded to pole and bracket, then bolted together with stainless-steel bolts.
Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire.
Match pole material and finish.

Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

Intermediate Handhole and Cable Support: Weathertight, 3-by-5-inch handhole located at midpoint of pole with cover for access to internal welded attachment lug for electric cable support grip.

Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

Cable Support Grip: Wire-mesh type with rotating attachment eye, sized for diameter of cable and rated for a minimum load equal to weight of supported cable times a 5.0 safety factor.

Platform for Lamp and Ballast Servicing: Factory fabricated of steel with finish matching that of pole.

Factory-Painted Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.
Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

Color: As selected by Architect from manufacturer's full range.

2.7 DECORATIVE POLES

Pole Material:

Cast ductile iron.
Cast gray iron, according to ASTM A 48/A 48M, Class 30.
Cast aluminum.
Cast concrete.
Spun concrete.
Steel tube, covered with closed-cell polyurethane foam, with a polyethylene exterior.

Mounting Provisions:

Bolted to concrete foundation.
Embedded.

Luminaire Brackets:

Cast ductile iron.
Cast gray iron.
Cast aluminum.

Pole Finish: As selected by architect from manufacturer’s full range.

2.8 POLE ACCESSORIES

Base Covers: Manufacturers' standard metal units, arranged to cover pole's mounting bolts and nuts. Finish same as pole.

PART 3 - EXECUTION

3.0 LUMINAIRE INSTALLATION

Luminaires: Set level, plumb, and square with ceilings, walls, and poles. Install lamps in each luminaire.

Fasten luminaire to indicated structural supports.

Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

Suspended Luminaire Support:

Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers.
Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of luminaire chassis, including one at each end.

Adjust luminaires that require field adjustment or aiming, as indicated on Drawings in the presence of Engineer. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources.

Protect installed luminaires from damage during the remainder of the construction period.

Clean lighting of dirt and construction debris upon completion of construction activities, prior to final acceptance by owner. Clean fingerprints and smudges from lenses and reflectors.

Replace any burnt out sources and non-working luminaire components prior to final acceptance by owner.

Connect wiring according to Division 26 Section "Building Wire and Cable."

Install remote drivers in accessible location as indicated or as required to complete installation, using conductors per manufacturer's recommendations and not exceeding manufacturer's recommended maximum conductor length to luminaire.

3.1 POLE INSTALLATION

Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.

Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features, unless otherwise indicated on Drawings:

Fire Hydrants and Storm Drainage Piping: 60 inches.
Water, Gas, Electric, Communication, and Sewer Lines: 10 feet.
Trees: 15 feet.

Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Division 03 Section "Cast-in-Place Concrete."

Foundation-Mounted Poles: Mount pole with leveling nuts and tighten top nuts to torque level recommended by pole manufacturer.

Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.
Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
Install base covers, unless otherwise indicated.
Use a short piece of 1/2-inch- diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

Embedded Poles with Concrete Backfill: Set poles in augered holes to depth below finished grade indicated on Drawings, but not less than one-sixth of pole height.

Make holes 6 inches in diameter larger than pole diameter.
Fill augered hole around pole with air-entrained concrete having a minimum compressive strength of 3000 psi at 28 days, and finish in a dome above finished grade.
Use a short piece of 1/2-inch-diameter pipe to make a drain hole through concrete dome. Arrange to drain condensation from interior of pole.
Cure concrete a minimum of 72 hours before performing work on pole.

Poles and Pole Foundations Set in Concrete Paved Areas: Install poles with minimum of 6-inch- wide, unpaved gap between the pole or pole foundation and the edge of adjacent concrete slab. Fill unpaved ring with pea gravel to a level 1 inch below top of concrete slab.

Raise and set poles using web fabric slings (not chain or cable).

3.2 BOLLARD LUMINAIRE INSTALLATION

Align units for optimum directional alignment of light distribution.

Install on concrete base with top 4 inches above finished grade or surface at bollard location. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 03 Section "Cast-in-Place Concrete."

3.3 INSTALLATION OF INDIVIDUAL GROUND-MOUNTING LUMINAIRES

Install on concrete base with top 4 inches above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 03 Section "Cast-in-Place Concrete."

3.4 CORROSION PREVENTION

Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

Steel Conduits: Comply with Division 26 Section "Raceway and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch-thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.5 GROUNDING

Ground metal poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."

Install grounding electrode for each pole, unless otherwise indicated.

Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

3.6 FIELD QUALITY CONTROL

Inspect each installed luminaire for damage. Replace damaged luminaires and components.

Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.

Verify operation of photoelectric controls.

Illumination Tests:

Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IESNA testing guide(s):

IESNA LM-5, "Photometric Measurements of Area Lighting."
IESNA LM-64, "Photometric Measurements of Parking Areas."
IESNA LM-72, "Directional Positioning of Photometric Data."

Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to emergency and retransfer to normal.

Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.7 DEMONSTRATION

Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain luminaire lowering devices. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 26 50 00

SECTION 26 74 00

ELECTRICAL FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.0 SUMMARY

This Section includes electrical work required to support the Communications Systems specified in Division 27 and 28 (Security Systems).

1.1 DESCRIPTION OF WORK

The Electrical Contractor shall provide electrical work and equipment as called for in the following Division 27 Specification Sections.

Basic Communications Requirements
Bidding
Quality Assurance
Common Work - Sleeves, Penetrations, and Firestopping
Common Work - Hangers and Supports
Electrical Technology - General Requirements
Electrical Technology - Grounding and Bonding
Electrical Technology - Conduit and Boxes
Electrical Technology - Underground Ducts and Raceways
Electrical Technology - Maintenance and Hand Holes

The requirements of these Sections are additional to, different from, or otherwise supplement the requirements of similar work specified in Division 26.

The requirements of these Sections serve as the basis for the requirements of this Section, and are incorporated by reference into this specification Section.

PART 2 - MATERIALS

2.0 THIS SECTION NOT USED

PART 3 - EXECUTION

3.0 THIS SECTION NOT USED

END OF SECTION 26 74 00

SECTION 27 00 10

BASIC COMMUNICATIONS REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

This Section specifies the basic requirements for Communications Systems installations as indicated or required, and includes requirements common to more than one Specification Section of this Division (such as related documents, related Sections, definitions, governing requirements, Contractor requirements, warranty requirements, submittal requirements/procedures, and project closeout requirements/procedures, as well as other requirements).

1.2 RELATED DOCUMENTS

The General Requirements of the Contract (including General and Supplementary Conditions, and the requirements of Division 1), apply to the work of this Division.

This Section may expand upon or supplement the General Requirements of the Contract. In the event of a conflict or discrepancy between this Section and the General Requirements of the Contract, the General Requirements of the Contract shall govern. However, if the requirement of this Section (or portion thereof) exceeds that of the General Requirements of the Contract, and is furthermore not contrary to the General Requirements of the Contract, then the requirement of this Section (or portion thereof) shall prevail.

Examine the Construction Documents in their entirety (including Drawings and Specification Sections in the other Divisions) for requirements or work which may affect work under this Section, regardless of whether such requirements or work are specifically indicated in this Section.

1.3 RELATED SECTIONS

All Specification Sections in this Division.

The following Sections in other Divisions:

Division 26 – Electrical for Communications Systems
Division 28 – Security Systems

1.4 COMMUNICATIONS SYSTEMS

The following Communications Systems are included within this Division or within Division 28 and included on the Communications (T-series) Construction Drawings. Refer to paragraph *DEFINITIONS* later in this Specification Section for further explanation of each system:

Communications Cabling System.
Electrical for Communications Systems.
Security System(s).
Network System(s).

1.5 INTENT AND INTERPRETATIONS

It is the intent of the Construction Documents that the Contractor shall include all items necessary for the proper execution and completion of the Work by the Contractor, resulting in complete and fully operational system(s) ready for the Owner's use, in full compliance with all applicable standards, codes and ordinances.

Work or product not specifically indicated in the Construction Documents, but which are necessary to result in complete and fully operational system(s) ready for the Owner's use, shall be provided by the Contractor.
The specification of certain products in the Construction Documents shall not be construed as a release from furnishing such additional products and materials necessary to furnish complete and fully operational system(s) ready for the Owner's use.

The Construction Documents include certain conventions in the use of language and the intended meaning of certain terms, words, and phrases when used in particular situations or circumstances. These conventions include:

Abbreviated Language: Language used may be abbreviated. Implied words and meanings shall be interpreted as appropriate. Words implied, but not stated, shall be interpreted as the sense requires. Singular words shall be interpreted as plural and plural words interpreted as singular where applicable and where the full context so dictates.
Imperative and Streamlined Language: Imperative and streamlined language is used generally. Requirements expressed in the imperative mood are to be performed by the Contractor. At certain locations in the text, for clarity, subjective language is used to describe responsibilities that must be fulfilled indirectly by the Contractor, or by others when so noted.
Abbreviations and Names: Trade association names and titles of general standards are frequently abbreviated. Where abbreviations and acronyms are used, they mean the recognized name of the trade association, standards generating organization, authority having jurisdiction, or other entity applicable to the context.
Words used in the singular shall also mean the plural, wherever the context so indicates, and likewise words in the plural shall also mean the singular, wherever the context so indicates.
Unless otherwise stated, words which have well known technical or construction industry meanings are used in accordance with such recognized meanings.
The terms "directed", "required", "permitted", "ordered", "designated", or "prescribed", as well as similar words shall mean the direction, requirement, permission, order, designation or prescription of the Engineer.
The terms "approved", "acceptable", "satisfactory", and similar words shall mean approved by, acceptable, or satisfactory to the Engineer.
The terms "necessary", "reasonable", "proper", "correct" and similar words shall mean necessary, reasonable, proper, or correct in the judgment of the Engineer.

Assignment of Specialists: The individual Specification Sections may require that certain specific construction activities be performed by specialists who are recognized experts in the operations to be performed. The specialists must be engaged for those activities, and such assignments are requirements over which the Contractor has no choice or option. Nevertheless, the ultimate responsibility for fulfilling the contract requirements shall remain with the Contractor.

This requirement shall not be interpreted to conflict with the enforcement of local building codes and similar regulations governing the work.

Drawings:

Drawings are diagrammatic and approximate in character, are not intended to show all features of required work, and do not necessarily indicate every required component. Symbols used on the Drawings are defined in the legend on the Drawings. Symbols indicated on the legend may not necessarily be required.

Drawings and Specifications are complementary. Items required by either are binding as though they are required by both.

1.6 DEFINITIONS

The definitions below are applicable to this Division:

General

Accepted/Acceptable: Work or materials conforming with the intent of the project, and in general, conforming to the pertinent information in the Construction Documents.
Approved/Approval: The written approval of the Engineer.
Accessible: Easy access. Access attained without requiring extensive removal of other materials to gain access.
Accessible Ceiling: Acoustical tile hanging ceilings (“Hard-lid” ceilings (concealed spine or sheetrock/gypsum ceilings), even when provided with access panels, are not considered an Accessible Ceiling.)
Agreement: The contractual agreement between the Owner and the Contractor.
By Others: A party or entity other than the Contractor. The Contractor shall engage the General Contractor, Architect, and/or Owner to determine this party or entity for consideration of pricing and/or execution of the Work.
Concealed: Hidden from sight in interstitial building spaces, chases, furred spaces, shafts, crawl spaces, etc.
Construction Documents: Collective term for the entire set of bound or unbound material describing the construction and services required, including all Drawings, Specifications, addenda issued prior to execution of the contract, and modifications issued after execution of the Contract (such as change orders, construction change directives, supplemental instructions, etc.).
Contract Documents: The Agreement (including other documents listed in the Agreement), Conditions of the Contract (General, Supplementary and other conditions), and the Construction Documents.
The Contract: The Contract Documents form the Contract. The Contract represents the entire and integrated agreement between the Owner and the Contractor and supersedes any prior negotiations, representations or agreements, either written or oral. The Contract shall not be construed to create a contractual relationship of any kind (1) between the Engineer and the Contractor, (2) between the Owner and a subcontractor, or (3) between any persons or entities other than the Owner and Contractor.
Contractor: The party responsible for providing the Communication System(s) as indicated herein.
Drawings: The graphic and pictorial portions of the Contract Documents, wherever located and whenever issued, showing the design, location and dimensions of the Work, generally including (but not limited to) plans, elevations, sections, details, schedules and/or diagrams.
Engineer: The party responsible for producing the Communication System(s) Construction Documents.
Exposed: Not concealed (see above) and not installed underground.

Final Completion: The date when the Engineer confirms in writing that the Contractor has completed the work in accordance with the Construction Documents, including completion of all punch list items, cleanup work and delivery of all required guarantees, warranties, licenses, releases and other required deliverables.
Furnish: To purchase, supply, and deliver to the project materials in new and operable condition, ready for installation.
Governing Requirements: Collective term for regulations, laws, ordinances, codes, rules, standards, requirements, guidelines, and recommendations that govern the installation and inspection of the work defined in the Contract Documents.
Governing Authority: Entities or their representatives charged with formation and/or enforcement of Governing Requirements, such as the Authority Having Jurisdiction (AHJ).
Install: To place in final position in fully operable, tested condition.
Inside Plant (ISP): Infrastructure within a building.
Or Equal: Materials approved for use by the Engineer and which are dimensionally suitable and operationally identical to the specified item.
Outside Plant (OSP): Infrastructure exterior to a building.
Owner: The Owner and the Owner's designated representative(s).
The Project: The total construction of which the Work performed under the Contract Documents may be the whole or a part, and which may include construction by the Owner and/or separate Contractors.
Provide: To furnish and install, complete, tested and ready for intended use.
Rough-in: Provide the Communications Pathway System, including (but not limited to) device boxes, pull boxes, wall boxes, floor boxes, poke-through devices, conduit, enclosures, cable tray, ducts/ductbanks, maintenance holes, hand holes, and other pathways and items indicated (or as required) for routing, supporting, and installing communications cables, devices, or equipment which shall be provided by others or provided under a subsequent set of Contract Documents.
Substantial Completion: The date when all work required by the Construction Documents shall be complete (subject to the final punch list to be prepared by the Engineer) and on which the applicable jurisdictional authorities have issued a temporary certification of occupancy.
Section: An individual Section of the Specifications.
Shown on Drawings: Noted, indicated, scheduled, detailed, or any other written reference made on the Drawings.
Specifications: The portion of the Contract Documents consisting of the written requirements for materials, equipment, construction systems, standards and workmanship for the Work and performance of related services.
Specification Section(s): One or more Sections of the Specifications.
Section(s): An abbreviated form of Specification Section(s).
The Work: The construction and services required by the Contract Documents, whether completed or partially completed, and all other labor, materials, equipment and services provided or to be provided by the Contractor to fulfill the Contractor's obligations. The Work may constitute the whole or a part of the Project.

Communications Systems

Communications Cabling System: Includes (but is not limited to) communications cables and patch cables, connectors, terminations and termination equipment and panels, equipment racks and distribution equipment, equipment required for the build-out of communications rooms and spaces, cable support equipment not covered under Communications Pathway System including, but not limited to J-hooks/Straps, and other incidental and miscellaneous product and labor as required.
Communications Infrastructure System: A Communications Cabling System in conjunction with a Communications Pathway System.

Electrical for Communications Systems:

Communications Pathway System: Includes (but is not limited to) device boxes, pull boxes, conduit, cable tray, duct/ductbank, and other pathway and raceway components necessary to provide pathway for, support, and route cables for Communications Systems.
Telecommunications Grounding and Bonding System: Includes (but is not limited to) providing a permanent grounding and bonding infrastructure for the Communications Cabling System.
Commonly referred to as Electrical Technology in the Division 27 Construction Documents.

Security System(s): Includes (but is not limited to) security cables, connectors, terminations and termination equipment, security equipment, equipment racks, equipment required for system configuration, programming and testing, and other incidental and miscellaneous product and labor as required.
Structured Cabling System (SCS): Alternative term for Communications Cabling System.

1.7 ABBREVIATIONS

Refer to the individual Specification Sections and Drawings for abbreviations and their definitions.

1.8 GOVERNING REQUIREMENTS

All work shall be executed in compliance with the applicable portions of the following Governing Requirements:

General

ACI: American Concrete Institute (www.aci-int.org)
ADA: Americans with Disabilities Act
AHJ: Authority Having Jurisdiction
ANSI: American National Standards Institute (www.ansi.org)
ASTM: American Society for Testing and Materials (www.astm.org)
BELLCORE: Bell Communications Research (www.telecorrdia.com)
BICSI: A Telecommunications Association (www.bicsi.org)
ETL: Electrical Testing Laboratories
IBC: International Building Code
ICEA: Insulated Cable Engineers Association (www.icea.net)
IEEE: Institute of Electrical and Electronic Engineers (www.ieee.org, www.standards.ieee.org)
IES: Illuminating Engineering Society of North America (www.iesna.org)
IFC: International Fire Code
FCC: Federal Communications Commission Rules and Regulations
NAB: National Association of Broadcasters
NFPA: National Fire Protection Association (www.nfpa.org)
NEC: National Electrical Code (NFPA Article 70) (www.nfpa.org, www.necdirect.org)
NESC: National Electrical Safety Code (http://standards.ieee.org/nesc/)
NEMA: National Electrical Manufacturers Association (www.nema.org)
NIST: National Institute of Standards and Technology (www.nist.gov)
OSHA: Occupational Safety and Health Administration (www.osha.gov)
RUS: Rural Utilities Service (http://www.usda.gov/rus/)
TIA: Telecommunications Industry Association (www.tiaonline.org)
UBC: Uniform Building Code

UFC: Uniform Fire Code (www.nfpa.org)
UL: Underwriters Laboratories, Inc. (www.ul.com, www.ulstandardsinfonet.ul.com)
State and local codes, ordinances, and regulations
Requirements and guidelines of local utility companies
Applicable state, local and/or federal laws, regulations, and/or specifications
Manufacturer installation requirements, guidelines and recommendations

Communication System Specific: The following portions of the General Governing Requirements above are particularly relevant to a given Communications System. Omission from this list does not alleviate the Contractor from responsibility for executing all Work for all Communications Systems in compliance with all applicable portions of the Governing Requirements above:

Communications Cabling System:

TIA 568: Commercial Building Telecommunications Cabling Standard
TIA 569: Commercial Building Standard for Telecommunication Pathways and Spaces
TIA 606: The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
ANSI/NECA/BICSI 607: Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings
ANSI J-STD-607: Commercial Building Grounding and Bonding Requirements for Telecommunications
TIA 758: Customer-owned Outside Plant Telecommunications Cabling Standard
ANSI 310-D: Cabinets, Racks, Panels and Associated Equipment
ANSI/TIA 942: Telecommunications Infrastructure Standard for Data Centers
TIA: Technical Service Bulletins (TSBs) (related to the above TIA standards)
ANSI/BICSI 004-2012, *Information Technology Systems Design and Implementation Best Practices for Healthcare Institutions and Facilities*.
IEEE 802.3 (series): Local Area Network Ethernet Standards
BICSI: Customer Owned Outside Plant Design Manual
BICSI: Information Transport Systems Installation Manual
BICSI: Network Design Reference Manual
BICSI: Telecommunications Distribution Methods Manual
BICSI: Wireless Design Reference Manual
NFPA 70: NEC: National Electrical Code (NFPA Article 70)
NFPA 75: Protection of Electronic Computer and Data Processing Equipment
NFPA 78: Lightning Protection Code
FCC Part 68: Connection of Terminal Equipment to Telephone Network.
FCC Part 76.611: CFR Title 47 Radiation Leakage Standards

Electrical for Communications Systems:

TIA 569: Commercial Building Standard for Telecommunication Pathways and Spaces
TIA 606: The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
ANSI/NECA/BICSI 607: Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings
ANSI J-STD-607: Commercial Building Grounding and Bonding Requirements for Telecommunications

TIA 758: Customer-owned Outside Plant Telecommunications Cabling Standard
ANSI/TIA 942: Telecommunications Infrastructure Standard for Data Centers
TIA: Technical Service Bulletins (TSBs) (related to the above TIA)
BICSI: Customer Owned Outside Plant Design Manual
BICSI: Telecommunications Cabling Installation Manual
BICSI: Telecommunications Distribution Methods Manual
NFPA 70: NEC: National Electrical Code (NFPA Article 70)
NFPA 75: Protection of Electronic Computer and Data Processing Equipment
NFPA 78: Lightning Protection Code
UL 467: Grounding and Bonding Equipment

Security System(s):

IBC: International Building Code
NFPA 72: National Fire Alarm and Signaling Code
NFPA 731: Standard for the Installation of Electronic Premises Security Systems
NFPA 101: Life Safety Code
UL 294: Standard for Access Control System Units
UL 1076: Proprietary Burglar Alarm Units and Systems
UL 2900-2-3: Software Cybersecurity for Network-Connectable Products

Owner Specific: The Contractor shall comply with the following Owner requirements. These requirements shall be incorporated by reference into these Specifications and shall be hereinafter considered a Governing Requirement:

AHJ

Nothing in the Governing Requirements and Construction Documents shall be construed to permit work not conforming to all governing codes and regulations.

Errors or omissions in the Construction Documents do not relieve the Contractor from executing the work in accordance with the Governing Requirements, including all governing codes and regulations.

The applicable portions of the Governing Requirements shall be incorporated by reference into each related Specification Section in this Division.

1.9 PERMITS AND FEES

The Contractor shall obtain and pay for all licenses, permits and inspections required by the laws, ordinances and rules governing work specified herein. Such fees shall be included in the bid amount.

The Contractor shall pay all fees, including but not limited to fees for local utility service installation, connection charges, etc. Such fees shall be included in the bid amount.

Notations on permit or review documents shall be observed. Additional requirements noted by the Governing Authority shall be made part of the requirements for construction of the Project. Additional costs for implementing these requirements, if any, shall be submitted for review prior to construction.

Engineering Fees: The Specifications may identify work required of the Engineer due to improper action(s), lack of action(s), and/or deficiencies on the Contractor's part. Such instances will be identified in the Specifications and the Contractor shall be responsible for these fees if they are incurred by the Engineer.

Fees charged to the Contractor will be at the Engineer's billing rates at the time the services are performed. Travel time will be included, if applicable. Mileage will be charged for required automobile travel at the standard IRS mileage rate in effect at the time the services were performed. Expenses will be billed at cost plus 10 percent markup.
Fees will either be paid directly to the Engineer or will be deducted directly from payments (or the final payment) to the Contractor.

1.10 SUBSTITUTIONS AND DEVIATIONS

The requirements below expand upon and/or supplement the requirements in Division 1.

Substitution of product and deviations from the methods of construction specified which are used in the Contractor's bid shall be at the sole risk of the Contractor, and as such are subject to rejection without consideration.

Proposed substitution and deviation requests shall be reviewed during the time of Submittal review:

Conditions for Consideration: Substitution and deviation requests will be received and considered only when one or more of the following conditions are satisfied:

A substantial advantage is offered to the Owner, in terms of cost, time, or other considerations of merit.
The specified product or method of construction cannot be provided with the contract period.
The specified product or method of construction cannot receive necessary approval by a Governing Authority, and the requested substitution can be approved.
The specified product or method of construction cannot be provided in a manner that is compatible with other materials.
The specified product has been discontinued or recalled by manufacturer, or has become technologically obsolete. In such cases, the substituted equipment shall be of like manufacturer, make, and model as specified product when possible.
The manufacturer of specified product has ceased business practices.
The product as specified includes the statement, "Or Equal."

Conditions for Rejection: Substitution and deviation requests will be rejected for the following reasons, among others:

The conditions for consideration (see above) have not been met.
Extensive revisions to the Construction Documents are required to support the proposed changes.
The proposed changes do not comply with the general intent of the Construction Documents.
The substitution request is for product which does not include the statement, "Or Equal", or is specified as "no substitute", "substitutions are not acceptable", "provide as specified" or similar.
The substitution and deviation is not of equal or greater value as specified product or design.
The proposed change is solely for the convenience or economic gain of the Contractor.

The Contractor shall not proceed with procurement or installation of a substitution or deviation without written approval.

Upon approval of the request, the Contractor shall be responsible for fees incurred by the Engineer for re-design work or modifications to the Construction Documents if necessitated by the nature of the request.

1.11 SUBMITTALS

The requirements below expand upon and/or supplement the requirements in Division 1.

Provide product data submittals for all equipment to be provided in which a manufacturer and part number have been listed on the equipment schedule(s) on the technology construction drawings.

General:

Submittal review is a courtesy extended to the Contractor for the limited purpose of checking for general conformance with the design concept and the information shown in the Construction Documents.
Prior to submission of any product or methods of construction submittal items, submit a Submittal Schedule indicating items to be submitted with respective dates. Schedule shall allow the Engineer's possession of each submittal for a minimum of two week(s). Schedule shall clearly indicate submittal items that will contain a “Substitution and Deviation Requests” section (see below) including a statement indicating condition for consideration of such as listed under requirements of *Part 1 – General: Substitutions and Deviations* herein.
The Contractor shall provide submittal information as soon as practicable after the date of Notice to Proceed and prior to the purchase, delivery, fabrication, and installation of product and materials.
In the event of discrepancies or conflict between Submittals and the Construction Documents, either prior to or after review, the requirements of the Construction Documents shall prevail.
Submission of material for review, regardless of the outcome of the review, does not alter the Contractor’s obligation to follow the intent of the Construction Documents, nor the Contractor’s responsibility to comply with the Construction Documents.
Submittals will not be reviewed and will be returned to the Contractor without review for the following reasons:

Submittal package does not conform to the requirements listed herein.
Submittal is for a product or method of construction not required by the Construction Documents.
Submittal is partial or incomplete. For example, a submittal shall be considered partial or incomplete if Product Data is not accompanied by related Shop Drawings.
Submittal contains information concerning the proposed implementation of means, methods, procedures, sequences or techniques, temporary aspects of the construction process, or other items, which are the sole responsibility of the Contractor.
Submittal was not carefully reviewed by the Contractor prior to submission, as evidenced by poor organization, obvious or numerous errors, lack of correlation or cross-referencing, lack of clarity in presentation, or containing Shop Drawings which do not meet the standard of the Construction Drawings.
Submittal was submitted directly from the Contractor’s subcontractor(s) or vendor(s).
Subcontractor and/or vendor submittal information was not carefully reviewed and/or approved by the Contractor.

Submittal does not bear the Contractor's approval stamp, and/or contains subcontractor and/or vendor submittal information which does not bear the Contractor's approval stamp.
Submittal contains substitution and/or deviation requests, which are not clearly identified as substitution or deviation requests in a separate "Substitution and Deviation Requests" section of the Submittal.

Submittals shall be submitted as a single package and shall include subcontractor and vendor submittal information.
Each submittal (or re-submittal) set shall bear a unique Contractor's submittal sequence number.
Requests for substitution shall only be included under the "Substitution and Deviation Requests" section of the submittal (see below) and shall comply with the requirements of *Part 1 – General: Substitutions and Deviations* herein. Submission of substitution requests in any other portion of the Submittal does not constitute an acceptable or valid request for substitution, nor will review of such information constitute approval in any manner.

Submittal Format:

Submittals shall be bound in one letter-sized (8-1/2 inch by 11 inch) document and under separate cover from submittals furnished under other Divisions.
Front cover of Submittal shall indicate the name of the project, the project number, the name of the Owner, year of completion, the title "Communications Submittals", and the names of the Engineer and Contractor, as well as the General Contractor.
Submittals shall include a table of contents identifying sections, Specification Sections, and page numbers.
Information provided in the submittal shall follow the same general order of the Specifications.
Submittals shall be sectionalized (Indexed with titled tab dividers (by section name – not numbered and not handwritten).

Sections shall be (see Submittal Sections below for more detail regarding each section):

Product Data
Shop Drawings
Substitution and Deviation Requests
Test Reports
Other Information

Within each section, information shall be organized by Specification Section and/or Drawing to which the information applies.
Within each section, where section is not applicable (e.g. shop drawings, technical drawings, etc.), the section shall include a page denoting same.

Pages shall be numbered.
Drawings (except for full and half-size Shop Drawings), if not in 8-1/2 inch by 11 inch size, shall be bound and accordion folded to 8-1/2 inch by 11 inch size.
Quantity: Submit copies in quantities per the requirements of Division 1.

Submittal Sections: Submittals shall be sectionalized and shall include sections for Product Data, Shop Drawings, Substitution and Deviation Requests, and Other Information (see Submittal Format herein).

Product Data: Submit Product Data information as called for in the individual Specification Sections. Product Data shall include:

For all product, provide the following product information (as applicable):

- Specification Section to which the product applies.
- Catalog cut sheets, manufacturer data sheets, and/or specification sheets detailing the product, item, assembly and installation.
- Manufacturer's printed recommendations (if not included in the above).
- Written description.
- Notation of dimensions verified by field measurement.
- Notation of coordination requirements.
- Compliance with recognized trade association and testing agency standards.
- Highlighted details within the product data that identifies compliance with the Construction Documents or the intent of the Construction Documents.
- Highlighted details within the product data that identifies deviations from the Construction Documents or the intent of the Construction Documents.

For products for which the Contractor is proposing a substitution, include the product as specified in the Submittal per the above requirements and list the reference to the proposed substitution in the "Substitution and Deviation Requests" section of the Submittal (see below).

Do not provide product quantities – quantities are the sole responsibility of the Contractor and will not be reviewed.

Shop Drawings: Submit Shop Drawings that are newly prepared, drawn to accurate scale, and that fully illustrate the Contractor's understanding of the intent and requirements of the Construction Documents (i.e. Shop Drawings shall not be based upon or consist of a reproduction of the Construction Documents or standard printed data). Submit Shop Drawings as called for in the individual Specification Sections. Shop Drawings shall include:

Identification of products and materials

Schedules, including but not limited to:

- Equipment and components
- Cables: identify manufacturer, model number, outside diameter and connector

Notation of coordination requirements

Notation of dimensions established by field measurement

Notation of details that identify compliance with the Governing Requirements

Notation of details that identify compliance with the Construction Documents or the intent of the Construction Documents.

Notation of deviations from the Construction Documents or the intent of the Construction Documents. *Highlight, encircle, or otherwise clearly indicate such deviations*

Roughing-in and setting diagrams

Fabrication, installation, and adaptation details including, but not limited to:

- Electronic equipment to be mounted within racks
- Cable routing between electronic equipment in racks or housings
- Equipment to be mounted within furniture
- Wall and ceiling mounted devices
- System labels, including but not limited to engraved, lamacoid, silk screen and paper labels
- Suspended loudspeaker mounting, including but not limited to tilt angle, splay angle, height above finished floor, coverage pattern, and assembled weight

Non-standard manufactured or adapted equipment
Dimensions
Other details as necessary to establish the intent of the Construction Documents

One-line diagrams detailing the interconnections of system components, including the identification of all devices, cabling, terminations, and termination techniques as required for fully functional systems
Applicable software block diagrams representing the internal operation of devices such as, but not limited to, control processors and digital signal processors
Templates
Floor plans identifying equipment locations, *if not shown on the Construction Documents*
Reflected ceiling plans identifying equipment locations, *if not shown on the Construction Documents*
Indication of sectionalized manufacturing of equipment (i.e. for oversized equipment that cannot be installed as a single component).
Shop drawings shall be provided in form, format and size identical to that of the Construction Drawings (the Construction Drawings set the standard). Shop Drawings that do not meet this standard shall be rejected without review.

Title Block: May be the Contractor's Title Block, but shall indicate Project name, manufacturer's name and logo, date of submittal, content of sheet, and sheet number.
Floor Plans: Plan titles, scales, north arrows, column lines, line types, fonts, and room names and numbers shall match that of the Construction Drawings.

For methods of construction for which the Contractor is proposing a deviation, include the method of construction as specified per the above requirements and list the reference to the proposed deviation in the "Substitution and Deviation Requests" section of the Submittal (see below).

Substitution and Deviation Requests: For each substitution and/or deviation request, include the following:

Whether the request is for substitution of product or a deviation from a construction method.
The Specification Section(s) or Drawing to which the request applies.
Reason for the request. (Note: the reason must conform to the requirements of *Part 1 – General: Substitutions and Deviations* herein.)
If a substitution, provide:

Specified product to which the proposed substitution applies.
Product Data for the substituted product.
Notation of differences between the proposed substitution and the specified item. *Highlight, encircle, or otherwise clearly indicate the substitution.*

If a deviation, provide:

Specified Drawing and/or method of construction to which the proposed deviation applies.
Shop Drawings showing the deviation.
Notation of differences between the proposed deviation and the specified drawing and/or construction method. *Highlight, encircle, or otherwise clearly indicate the deviation.*

Written statement signed by the Contractor stating that the proposed substitution or deviation is equivalent or superior in function, appearance, and quality to the specified product or construction method and that the proposed substitution or deviation will be at no additional cost to the Owner.

Test Reports:

Submit full-size mock-ups of the test reports that will be used to document the testing.

Other Information:

Contractor Statement of Qualifications, per Division 27 Specification Section *Contractor Qualifications.*
Bid Form or Bid Supplement Form, per Division 27 Specification Section *Bidding*.
Owner Specific: Submit other information as required by Owner Specific Governing Requirements.
Submit additional information as called for in the individual Specification Sections.

Submittal review:

The submittal review will not include review of the accuracy or completeness of details, such as quantities, dimensions, weights or gauges, fabrication processes, construction means or methods, coordination of work with other trades, or construction safety precautions, all of which are the sole responsibility of the Contractor.
Corrections or comments made on the Submittal by the reviewer during the submittal review do not relieve the Contractor from compliance with the requirements of the Construction Documents.
Review of a specific item shall not indicate that the reviewer has reviewed the entire assembly of which the item is a component.
Review does not relieve the Contractor from responsibility for errors, which may exist in the submitted data.
Review of substitutions and deviations:

The reviewer shall not be responsible for review of substitutions and/or deviations that were not brought to the attention of the reviewer by specific inclusion of the substitution and/or deviation in the Substitution and Deviation Requests section of the Submittal.
Where a substitution and/or deviation is not included in the Substitution and Deviation Requests section of the Submittal, the procurement and installation of the substitution and/or deviation is at the sole risk of the Contractor.
If the reviewer does not specifically note substitutions and/or deviations, it remains the Contractor’s responsibility to comply with the Construction Documents.

After review, submittals shall be returned together with review comments and specific actions (if required) to be taken by the Contractor. Typical comments and actions will be:

Reviewed - resubmittal not required
Rejected - resubmittal required
Revise and Resubmit - resubmittal required
Make Corrections as Noted - resubmittal not required

The Contractor shall perform no portion of the Work requiring a submittal until the respective submittal has been reviewed and approved. Such Work shall be in accordance with the approved submittal.

Re-submission of submittals:

Submittals shall continue to be re-submitted and reviewed until all submitted items are marked by the Engineer as 'No Exceptions Taken' or 'Revise - Re-submittal Not Required'.
Re-submittals shall be clearly identified as a re-submittal and shall identify changes on a separate Revisions page inserted after the Table of Contents page(s).
The Contractor shall be responsible for fees incurred by the Engineer resulting from subsequent review of re-submittals that fail to meet the requirements herein. Such fees will be incurred after the Engineer has reviewed the original submission and one re-submission.
Re-submittals do not entitle the Contractor to additional time, nor are they considered cause for delay of the project.

1.12 RECORD DOCUMENTS

The requirements below expand upon and/or supplement the requirements in Division 1.

The Contractor shall maintain a set of Record Documents showing all additions, changes, and deletions that have been made to the original Drawings and Specifications throughout the course of construction, as well as reviewed Submittal data, including but not limited to Shop Drawings.

Items to be noted shall include but shall not be limited to:

Final device box, pull box, floor box, sleeve and conduit stub/ poke thru locations
Final locations, sizes, and dimensions of equipment, including concealed equipment
Routing of concealed raceways/pathways
Raceways/pathways located more than 2 feet from where shown on the original Construction Documents
Raceways and main pathways (pathways with more than 30 cables) not shown on the Drawings
Building outline changes
Addenda, accepted Alternates, Change Orders, other document revisions which occurred after the award of the Contract and/or the start of construction activities
System component labels (including outlet numbers) and identifiers for all major components
Shop Drawings, including those submitted for approval and those used for construction but not required for submission.

Notations shall be in a neat, legible and logical manner. Areas affected by the change shall be clouded.

Record Documents shall:

Be kept current (i.e. no more than one week behind actual construction) throughout the course of construction.
Be retained at the job site until Final Acceptance.
Be made readily available at all times to the Owner's representative.
Not be the Contractor's working documents.
Be protected from deterioration and loss in a secure, fire-resistive location.
Be made readily available to the Engineer for review of completeness and accuracy throughout the course of construction.
At project closeout, be updated with the items on the Known Exceptions/Deviations List per the requirements of *Part 3 – Execution: Project Close-Out*, herein. Include only those items marked "Approved" by the Engineer.

Submission:

Unless otherwise indicated, handwritten notations on Record Drawings shall be submitted to Engineer during Project Close-Out site visit.
The Record Drawings shall be reviewed by the Contractor for accuracy and completeness prior to submission.

Owner Specific:

Submit other information as required by Owner Specific Governing Requirements.

Submit additional information as called for in the individual Specification Sections.

1.13 OPERATING AND MAINTENANCE (O&M) MANUALS

General:

O&M Manuals shall be submitted in accordance with the applicable portions of Division 1.
O&M Manuals shall be submitted as a single package and shall include subcontractor and vendor O&M information.
O&M Manuals shall be prepared by personnel who are:

Completely familiar with the requirements of this Section
Trained and experienced in the maintenance and operation of the described products
Skilled as a technical writer to the extent required to communicate essential data
Skilled as a draftsperson competent to prepare the necessary Drawings

Catalog pages and data included in O&M Manuals shall be originals. Where not possible to obtain original copies in sufficient quantity, catalog pages and data shall be neat, clean copies of the originals.
O&M Manuals shall include the following:

Table of Contents
Operations: Assemble operations and instructions data which shall include all procedures necessary for activating and controlling each system and/or component in all modes of operation and for fulfilling all functional requirements.
Product Data: Include the product data provided in the original Submittal(s) reflecting product as supplied and installed, as well as additional information such as manufacturer, installation, operation, routine maintenance information, and technical specifications.
Shop Drawings: Include the Shop Drawings provided in the original Submittal(s) reflecting the system and/or components as installed.
Service Information: Assemble service information (cleaning, adjustments, frequency, etc.) for each device requiring service. For devices requiring qualified service, compile an index of qualified service providers (and their contact information) able to service these devices. Provide a recommended maintenance schedule for each device.
Spare Parts: Assemble a list of spare parts. Compile an index of spare parts providers (and their contact information) able to provide the spare parts.
Tests Results: Assemble all test documentation made for each system, device, and/or component requiring testing.
Calibration/Configuration Settings: Assemble and document all calibration/configuration settings made for each system, device and/or component requiring calibration and/or configuration. Include ‘normal’ settings for each component.

Record Documents: Provide Record Documents per the requirements of *Part 1 – General: Record Documents* herein.
Final punchlist: Provide the final punchlist including all corrective action taken and Contractor initials per the requirements of *Part 3 – Execution: Project Close-Out*.
Certificates of Inspection: Provide certificates of inspection and final approval from all applicable Governing Authorities, the Manufacturer(s), the Contractor's RCDD, etc.
Warranty: Provide warranty documentation per the requirements of Division 27 Specification Section *Warranty* and the individual Specification Sections.
Software, including but not limited to:

All source code for custom programs. Source code shall be provided on CD-ROM.
System software
Computer system operating software
Application software
Version Documentation: Provide a spreadsheet in MS Excel format documenting all software and firmware versions for all programmable devices. Provide in both printed format and on CD-ROM.

Other Information:

Submit additional information as called for in the individual Specification Sections.
Owner Specific: Submit other information as required by Owner Specific Governing Requirements.

O&M Manual contents shall also be submitted in both hard copy and soft copy on CD-ROM.

O&M Manual format:

O&M Manuals shall be bound in one letter-sized (8-1/2 inch by 11 inch) hard cover (hard back or loose leaf) binder.
Separate O&M Manuals shall be provided for each Communication System (i.e. Communications Cabling, Audiovisual, Security, etc.)
Front cover of the O&M Manual shall indicate the name of the project, the project number, the name of the Owner, the title of the O&M Manual indicating the communications system (Communications Cabling System O&M Manual, Audiovisual System O&M Manual, Security System O&M Manual, etc.), the year of completion, the name of the Engineer, the name of the Contractor, and as applicable the names of the Architect and the General Contractor.
Side cover of the O&M Manual shall indicate the name of the project, the project number, the name of the Owner, and the title of the O&M Manual.
O&M Manual shall include each section defined under *O&M Manual Requirements* above.
O&M Manuals shall include tab dividers, titled (not numbered) for each section. Tab dividers shall not be handwritten.
O&M Manuals shall include a table of contents identifying sections and page numbers. Pages within each section shall be numbered.
Drawings (excluding full size Record Drawings) shall be bound and accordion folded to 8-1/2 inch by 11 inch size.

O&M Manual submission:

The Contractor shall submit one draft copy of the O&M Manual for review and approval by the Engineer.

The submission will be reviewed for accuracy, completeness, and compliance to the requirements herein. A submission which fails to meet these requirements will be rejected and returned to the Contractor together with review comments and specific actions to be taken by the Contractor. The Contractor shall revise the O&M Manual and re-submit for review and approval.
The O&M Manual shall continue to be re-submitted and reviewed until such time as the O&M Manual is approved by the Engineer.
The Contractor shall be responsible for fees incurred by the Engineer resulting from subsequent review of O&M Manuals that fail to meet the requirements herein. Such fees will be incurred after the Engineer has reviewed the original submission and one re-submission.

Upon approval of the draft copy, the Contractor shall submit final copies in quantities per the requirements of Division 1.

Final payment to the Contractor will not be authorized until the final copies of the O&M Manuals (including Record Documents) have been received and approved by the Engineer.

PART 2 - MATERIALS

2.1 GENERAL

Part Numbers: Refer to the equipment schedule(s) on the Technology Construction Drawings for specific manufacturers and part numbers. If no part number is provided, then any part meeting the manufacturer and requirements specified is acceptable.

Where one or more products are listed for a specified component:

The product listed first shall establish size, capacity, grade, quality, technical specifications, and the basis of design.
Products not listed first shall be considered “other acceptable” products. Should the Contractor choose to use those products, costs for changes to the construction required to support the use of these products shall be borne by the Contractor.

If no product is listed, then any manufacturer able to meet the listed Specifications is acceptable.

The Contractor is responsible for providing submittals for product as indicated and shall comply with the requirements of *Part 1 – Submittals* herein. Substitutions shall comply with the requirements of *Part 1 – General: Substitutions and Deviations* herein.

Unless otherwise indicated, where product is specified without the statement “or equal”, substitutions will not be considered.

2.2 MATERIALS

The Contractor is responsible for providing all incidental and/or miscellaneous tools, scaffolding, consumable items, testing equipment appliances, and other hardware not explicitly specified or shown on the Drawings required for the installation of a complete and operable systems ready for the Owner’s use.

Products shall be:

New and unused, free from blemish and defects.
Standard products of manufacturers regularly engaged in the production of such products.
Of the manufacturers latest standard design at the time of procurement,

Designed to ensure satisfactory operation and life in the environmental conditions that prevail in their installation location.
Designed for application in commercial/professional systems, except as otherwise specifically noted.

All products, whether stock or custom, shall be supported by replacement parts and manufacturer schematic drawings as applicable. “Black box” and/or unidentified components are not acceptable.

All products of the same or similar type shall be the product of one manufacturer.

All component products within a unified system shall be the product of one manufacturer.

Equipment shall be UL listed, or equivalent.

2.3 DELIVERY, STORAGE, AND HANDLING

Prior to ordering and delivery of equipment, the Contractor shall:

Verify that the equipment shall adequately pass through building openings and passageways with unobstructed access to the final equipment location. When building openings and passageways will not permit the equipment to pass through unobstructed, equipment shall be manufactured and shipped in sections for final assembly at the equipment location.
Verify that the equipment shall properly fit the space allocated, that required clearances can be maintained, and that the equipment can be located without interference from other systems, structural elements, or the work of other trades.

The Contractor shall arrange deliveries in accordance with the construction schedule. Deliveries shall be scheduled to maintain the progress of work, to avoid conflict with the work of other Trades, and to accommodate site conditions.

The Contractor shall be responsible for coordinating and scheduling the timely delivery of products and materials indicated to be furnished by others or by the Owner.

Deliver, store and handle products and materials in full compliance with the manufacturer’s recommendations and/or instructions, using means and methods that will prevent damage, deterioration, and loss (including theft).

The Contractor shall protect products and materials until Final Acceptance. Such protection is the sole responsibility of the Contractor, and the Contractor shall be responsible for replacing damaged, deteriorated, stolen or lost product at no additional cost to the Owner.

Where products and materials are indicated to be furnished by others or by the Owner, the Contractor shall make a complete and careful check of all materials delivered. The Contractor shall provide a written and signed receipt acknowledging acceptance of the delivery and the condition of the materials delivered. After receipt, the Contractor shall assume full responsibility for the materials.

Products and materials subject to damage by the elements shall be stored above ground, under cover, in a weather tight enclosure, with ventilation adequate to prevent condensation. Temperature and humidity shall be maintained within the manufacturer’s recommendations.

The Contractor shall make provisions for receiving and storing products and materials, including products and materials to be furnished by the Owner (or by others) to be installed by the Contractor as part of the work.

Products and materials shall be carefully inspected for damage upon delivery. Defective or damaged products and materials shall be marked 'Rejected', removed from the site, and shall not be installed.

Products and materials shall be delivered to the site in the manufacturer's original containers, complete with labels and instructions for the proper handling, storage, unpacking, protection and installation.

The Contractor shall ensure that products and materials to be installed are not temporarily used as steps, ladders, platforms, scaffolds, or for storage by the Contractor or by other trades during the construction process. Materials found to be used in such a manner will be considered "damaged", shall not be installed, and shall be replaced at no additional cost to the Owner.

PART 3 - EXECUTION

3.1 GENERAL

Work shall comply with the latest edition of applicable portions of the Governing Requirements in effect at the time of construction, including all addenda, errata, annexes, and technical service bulletins (TSBs), etc., except where a specific edition is otherwise indicated, or where otherwise mandated by a Governing Authority. Where the specific edition is indicated for a Governing Requirement that is not mandated by a Governing Authority, and a later edition is available for such Governing Requirement at the time of construction, the more stringent applicable provisions of both the latest and specifically indicated editions of such Governing Requirement shall prevail.

In the event of a conflict between a code and the other Governing Requirements, or between a code and a requirement of the Construction Documents, the code requirement shall govern. However, if the non-code requirement (or portion thereof) exceeds that of the code, and is furthermore not contrary to the code, the non-code requirement (or portion thereof) shall prevail.

Installation shall be performed by workers skilled in the trade, familiar with the particular techniques and methods of construction applicable to the work of the trade.

Completed work shall present a neat and professionally installed appearance. The appearance of the work shall be of equal importance to its operation. Failure to present a neat and professionally installed appearance shall be considered sufficient reason for rejection of the system in part or in whole.

Completed work shall demonstrate quality workmanship. Quality workmanship shall be of equal importance to its operation. Failure to demonstrate quality workmanship shall be considered sufficient reason for rejection of the system in part or in whole.

In the event that supplemental information is required to confirm the intent of the Construction Documents, the Contractor shall notify the Engineer and await the Engineer's response prior to procurement of materials and performance of the related work. Procurement of materials and work performed without such interpretation and/or clarification is at the sole risk of the Contractor, and as such, the Contractor shall correct such work at no additional cost to the Owner should the materials or work not conform to the intent of the Construction Documents.

The Contractor shall order and install materials and equipment with long lead times and/or those having a major impact on work by other trades so as not to jeopardize the project or project schedule.

The Contractor is responsible for ensuring that each installed component's performance is within the Manufacturer's published specifications, the Governing Requirements, and all other requirements as specified within this Division.

The Contractor is solely responsible for the safety of the public and workers in accordance with all applicable rules, regulations, building codes and ordinances, and Governing Requirements, including but not limited to employee training and Safety Program development, documentation and execution.

Notwithstanding any other provisions of the Contract Documents, the Contractor shall be solely responsible for location and protecting any and all utility service lines (both Owner controlled and Public) in the work area.

3.2 SUPERVISION

The Contractor shall appoint a Project Manager who will be the single point of contact for all work accomplished under this Project and will be vested by the Contractor with the authority to make decisions on behalf of the Contractor.

The Project Manager will be responsible to represent the Contractor and coordinate all aspects of this Project, including but not limited to:

Overall and specific project responsibility
Thorough knowledge of Project Specifications and Drawings
Creation and maintenance of a project schedule, including milestones, task definitions and resource allocations
Attendance at all Project Management meetings
Supervision and direction of all Contractor personnel
Documentation, including submittals and change orders
Quality assurance of Project

The Project Manager initially assigned to the Project shall be assigned to the Project for the duration of the Project. Once assigned by the Contractor, the Project Manager shall not be changed by the Contractor without Engineer and Owner approval.

The Contractor shall assign a qualified Foreman to the Project and shall keep the Foreman on site and in charge of the work at all times. The Foreman shall be equipped with a mobile phone during project working hours.

The Foreman initially assigned to the Project shall be assigned to the Project for the duration of the Project. Once assigned by the Contractor, the Foreman shall not be changed by the Contractor without Engineer and Owner approval.

3.3 PERMITS AND FEES

The Contractor shall make arrangements to obtain and pay for necessary permits, licenses, and inspections.

No work shall be started prior to obtaining necessary permits and payment of required fees. Work installed prior to obtaining proper permits shall, if required by the Governing Authority (AHJ), be redone in compliance with requirements at no additional cost to the Owner.

3.4 INSTALLATION

The Contractor shall notify the Engineer and wait for direction/instruction prior to proceeding with procurement and installation for any portion of the Work which could be affected by the following:

Required items and/or details have been omitted from the Construction Documents.

Discrepancies or conflicts exist between the requirements of the Drawings and the Specifications, between the Governing Requirements and the Construction Documents, and/or between the various Governing Requirements.
Discrepancies or conflicts between the requirements of this Division and those of Division 1.

Dimensions and clearances:

Equipment dimensions and dimensions indicated for the installation of equipment are restrictive dimensions. Verify that the equipment will fit within the indicated locations and spaces.
Maintain, at a minimum, code required clearances.
Promptly notify the Engineer of any potential dimension or clearance conflicts, and await the Engineer's direction prior to purchase and rough-in of the equipment.

Access:

Install equipment such that it is readily accessible for operation and maintenance.
Access to equipment shall not be blocked or concealed by conduits, supporting devices, boxes, or other items.
Do not install equipment such that it interferes with the normal operation or maintenance requirements of other equipment.

Equipment shall be installed level, plumb, parallel, and perpendicular to building structures and to other building systems and components, except where otherwise indicated.

Seismic Bracing: Equipment shall be seismically braced as required by the governing requirements. Bracing shall be rigid – non-rigid bracing (chains, cables, etc.) is not acceptable, unless otherwise recommended by the manufacturer and approved or specified by the governing requirements. Seismic bracing hardware shall be provided by the manufacturer, or shall be approved or recommended by the manufacturer. Where no manufacturer hardware, approval, or recommendation is available, the seismic assembly shall be approved by a licensed structural engineer.

Equipment shall be securely fastened. Select fasteners so that the load applied to any one fastener does not exceed 25 percent of the proof-test load.

Place equipment labels and/or other identification where the label and/or identification can be easily seen and read without difficulty.

Grounding/Bonding: Bond all non-current carrying raceway to the nearest TGB.

Attachment of hanger rods, support cables, diagonal wall bracing, and any other connections made to the building structure after the application of fireproofing/firestopping materials, shall be made with minimal impact to the fireproofing/firestopping materials. The Contractor making such connections shall remove only as much fireproofing/firestopping as required for the attachment, and for scoring and over-cut only as required for the connection. The Contractor shall be held responsible for costs associated with patching of excessively removed fireproofing/firestopping material.

Cables, conduits, and other raceway shall be firmly secured and cleaned where penetrating fire rated barriers.

3.5 DRAWINGS

Drawings shall not be scaled for rough-in measurements or equipment locations. Field verification of dimensions, locations, and levels to suit field conditions is required. Final placement of devices, outlets, equipment, etc. shall be coordinated with field conditions.

Unless specifically dimensioned or detailed, Drawings indicate approximate locations, arrangement, and general character. To avoid interference with structural members and equipment of other trades, or for the convenience of the Owner, it may be necessary to adjust the locations shown on the Drawings prior to installation. Unless specifically dimensioned or detailed, and with the exception of locations of equipment and raceway in specialized communications rooms and spaces (such as Telecommunications Rooms, Data Centers, etc.), the Contractor may make minor location adjustments without obtaining the Engineer's prior approval. All other adjustments require prior approval from the Engineer.

Minor adjustments are defined as distances not to exceed:

1 foot at grade, floor ceiling, and roof level in any direction in the horizontal plane
1 foot on walls in a horizontal direction within the vertical plane.

Particular attention shall be paid to door swings, piping, ductwork, structural steel, and other ceiling conflicts:

In general, waste and vent lines, large pipe mains, and ductwork shall be given priority for the locations and spaces shown.
In general, electrical lighting fixtures shall be given priority for ceiling space.

Where minor location adjustments are required, such adjustments shall be made at no additional cost to the Owner.

3.6 ASBESTOS, LEAD, OR OTHER HAZARDOUS MATERIALS

In the event the Contractor encounters suspected asbestos, lead, or other hazardous materials, the Contractor shall immediately stop work in the area affected and report the condition to the Owner verbally followed by written notice. Work in the affected area shall not be resumed except by written agreement between the Owner and the Contractor.

3.7 RESTORATION

The Contractor shall restore all floors, ceilings, walls, furniture, grounds, pavement, etc. affected or damaged by the Contractor's work. All such areas shall be restored to original condition at no additional cost to the Owner.

The Contractor shall restore to original finish all new products, materials, and equipment scratched, chipped, or otherwise marred by the Contractor.

Restoration in every instance consists of completing the work to match and blend with the adjoining existing work insofar as methods, materials, colors, and workmanship are concerned.

Restoration work shall be performed by workers qualified and skilled in the trades involved.

Where restoration work requires painting: Painting shall consist of cleaning, surface preparation, painting (primer, intermediate, and finish) and finishing surfaces, for items both new and existing, affected by the work of the Contractor. Surface painting shall match and blend with existing adjoining surfaces. The areas around penetrations, once sealed, shall be painted.

The Contractor shall be responsible for replacing improperly matched, blended, or poorly constructed restorative work at no additional cost to the Owner.

3.8 HOUSEKEEPING

During the course of construction:

The Contractor shall keep the building, premises and surrounding area free from accumulated surplus, waste materials and rubbish at all times.
At the conclusion of each work shift, remove empty boxes, crates, surplus and waste materials, and other debris, and sweep clean all work areas affected by the Contractor's work.
In occupied areas affected by the Contractor's work, the Contractor shall remove all evidence of the Contractor's work in those areas at the end of each work shift, including tools, equipment and scaffolding, leaving the area clean, unobstructed and fully useable by the occupants.

At project completion, and prior to Final Acceptance:

Remove all tools, equipment and scaffolding.
Remove temporary labels and adhesives.
Thoroughly vacuum the interior of enclosures to remove debris.
Clear surplus product, materials and debris from the job site.
Turn over equipment to the Owner in unblemished condition.
Thoroughly clean equipment and facilities inside and out, and remove all residue -- all areas affected by the Work shall cleaned.
Turn over the Work to the Owner in a fully operational state.

All final cleanup work shall be performed by professional cleaners qualified and skilled in the trade. The Contractor shall not make use of unqualified personnel for cleanup work.

The Project shall not be considered complete until all area affected by the Work are left in a clean, neat, orderly, and fully operable condition.

3.9 SUBSTANTIAL COMPLETION

Due to the technical nature of the Work, as well as the requirement that certain Owner provided equipment, systems, and training may necessitate use of the Work by the Owner prior to Substantial Completion, the Owner reserves the right to use the Work prior to Substantial Completion (when ready for use) without obligation to the Contractor and without implying Acceptance of the Work.

Pre-Substantial Completion Submittal: Three weeks prior to Substantial Completion, the Contractor shall prepare and submit the following:

Known Exceptions/Deviations List:

The Contractor shall compile a thorough list of known exceptions/deviations (in materials, construction, and/or workmanship) from that specified in the Contract Documents, and for which there was not associated documentation in the form of Change Orders (CO), Construction Change Directives (CCD), Architects Supplemental Instructions (ASI), or responses to a Request for Information (RFI). The Contractor shall submit the list to the Engineer for review. The Engineer shall review each item and mark as either Accepted or Not Approved.

Items marked “Not Approved” shall be corrected by the Contractor to conform with the intent of the Contract Documents at no additional cost to the Owner.
The Contractor shall perform corrective action for “Not Approved” items prior to notifying the Engineer that the work is Substantially Complete.

Other information as called for in the individual Specification Sections.
Owner Specific: Submit other information as required by Owner Specific Governing Requirements.

Notice of Substantial Completion: When the Work nears Substantial Completion, the Contractor shall notify the Engineer in writing the date that the work will be Substantially Complete and ready for review by the Engineer.

3.10 PROJECT CLOSE-OUT

Punchlist:

Once notice of Substantial Completion is received, the Engineer shall visit the site to review the Work, and shall prepare a punchlist of items determined to be incomplete, deficient or otherwise not in compliance with the intent of the Contract Documents.

During the review of the Work, if the Engineer finds that the Known Exceptions/Deviations List provided by the Contractor was insufficiently thorough, that the Work is not Substantially Complete, or that deficiencies in the work are excessive, the Engineer will cease review and inform the Contractor that the work is not Substantially Complete. The Contractor shall be responsible for fees incurred by the Engineer for this partial review.

The Contractor shall perform corrective action for each item noted in the punchlist. When complete, the Contractor shall submit the original punchlist with each item initialed attesting to the fact that the item was corrected.

If necessary, the Engineer will perform a subsequent review after receipt of the Contractor initialed punchlist.

Should additional reviews beyond the original punchlist review be required of the Engineer due to the Contractor’s failure to correct all incomplete, deficient, or non-compliant work, the Contractor shall be responsible for fees incurred by the Engineer for the additional reviews.

Provide O&M Manuals per the requirements of *Part 1 – General: Operating & Maintenance (O&M) Manuals* herein.

END OF SECTION 27 00 10

SECTION 27 00 20
CONTRACTOR QUALIFICATIONS

PART 1 - GENERAL

1.1 SUMMARY

This Section defines Contractor qualifications and requirements for bidding the various systems in this Division.

1.2 QUALIFICATIONS FOR BIDDING

Contractors shall be qualified to bid per the requirements of *Part 1 – General: Contractor Qualifications* herein. Qualification criteria shall be satisfied prior to the date of Bid.

Pre-qualified Contractors:

The following Contractors have met the qualification requirements and are pre-approved (by system type) to bid the Work:

Communications Cabling System:

American Datapath (Ron Griffith, 303-922-8887)
Black Box Network Services (Ryan Muniz, 303-623-2631 ext. 1121)
E2 Optics (Doug Hodges, 303-358-7868)
Gigaspan (Anthony Wing, 303-284-3453)
Interface Communications CO. (Dave Trujillo, 303-530-4212)
Team Linx, LLLP (Kevin Koller, 303-307-3622)
National Network Services (Jeff Bowlus, 303-302-8422)
Piper Communication Services, Inc. (Rick Prouty, 303-456-1060)
Sturgeon Electric Special Systems Division (Lori Spitz, 720-505-6782)
Qcomm Network Services (Dave Nelms, 719-593-8300)

Security System(s):

Video Surveillance

Electronic Systems International (Rich Castle, 719.473.2660)
Linx (Ken Beckey, 303-961-5177)
National Network Services (John Fitzgerald, 303-302-8422)
Beacon Communications (Eric Holtorf, 303-750-6500)
Convergint Technologies (Rob Phillips, 303-932-0757)
E2 Optics (Tom Owens, 866-973-1507)
Pillar Integrations (Jeremy McAllister, 719-465-1473)
VTI Security (Brian FitzGerrell, 720-490-6620)
Stone Security (Brent Edmunds 877-888-0129)

Access Control:

Electronic Systems International (Rich Castle, 719.473.2660)
Linx (Ken Beckey, 303-961-5177)
National Network Services (John Fitzgerald, 303-302-8422)
Beacon Communications (Eric Holtorf, 303-750-6500)
Convergint Technologies (Rob Phillips, 303-932-0757)
E2 Optics (Tom Owens, 866-973-1507)
Pillar Integrations (Jeremy McAllister, 719-465-1473)
VTI Security (Brian FitzGerrell, 720-490-6620)

Stone Security (Brent Edmunds 877-888-0129)

Intrusion Detection:

Electronic Systems International (Rich Castle, 719.473.2660)
Linx (Ken Beckey, 303-961-5177)
National Network Services (John Fitzgerald, 303-302-8422)
Beacon Communications (Eric Holtorf, 303-750-6500)
Convergint Technologies (Rob Phillips, 303-932-0757)
E2 Optics (Tom Owens, 866-973-1507)
Pillar Integrations (Jeremy McAllister, 719-465-1473)
VTI Security (Brian FitzGerrell, 720-490-6620)
Stone Security (Brent Edmunds 877-888-0129)

Electrical For Communications Systems:

Refer to Division 26 for Electrical Contractor requirements.

Contractors not listed above must be qualified to bid per the requirements of *Part 1 – General: Contractor Qualifications* herein. Contractors shall submit their Statement of Qualifications (see *Part 1 – General, Statement of Qualifications* herein) with their bid. Bids which are submitted without a Statement of Qualifications or bids submitted with a Statement of Qualifications that is incomplete or does not clearly demonstrate that the qualification requirements have been met shall be rejected.

1.3 CONTRACTOR QUALIFICATIONS

General

Experience:

Governing Requirements: The Contractor shall have demonstrated, in-depth and working knowledge of the applicable portions of the Governing Requirements as noted in Division 27 Specification Section *Basic Communications Requirements* and as they pertain to the systems to be installed by the Contractor. The Contractor shall provide a signed statement stating same.
Design and Installation Practices: The Contractor shall have demonstrated, in-depth and working knowledge of the generally accepted design and installation practices for the systems to be installed by the Contractor. The Contractor shall provide a signed statement stating same.
Contractor References:

Project: The Contractor shall provide references for no less than five similar projects (in terms of size and construction cost) performed by the Contractor within the past three years.

The reference list shall detail, for each project:

i. Project name and location
ii. Construction cost
iii. A brief description of the project and the components involved
iv. Contact names, phone numbers, and addresses
v. Date completed

A minimum of two of the references shall be in the vicinity of the Project and shall be available for the Owner and Engineer to visit and inspect the installation. The Contractor shall highlight or otherwise make note of these particular references.

Service Department: The Contractor shall provide a minimum of two references for the Contractor's Service Department. A minimum of one of the references shall be in the vicinity of the Project.

Manufacturer(s) Certification:

The Contractor shall be trained and certified by the Manufacturer(s) to install, test, and maintain the major components of the system, shall be certified to perform service and equipment modifications without voiding the Manufacturer(s) warranty, and shall be certified by the Manufacturer(s) to provide these services in the location in which the Work is to be performed. The Contractor shall provide evidence of same for each major component Manufacturer – statements on letterheads from distributor, importer or local sales representatives are not be acceptable.

Offices:

Locations: Provide locations of all regularly/fully staffed and operational offices and the number of administrative staff and technical personnel in each. Indicate which office(s) have a Service Department, and of those offices, indicate the number and type of personnel staffing the Service Department.
Service Department: The Contractor shall maintain a permanently staffed and equipped Service Department, regularly providing services for the systems to be installed by the Contractor. The Contractor shall provide a signed statement stating same.
The Contractor shall be licensed, bonded, and insured in the State in which the Work is to be performed. The Contractor shall provide evidence of same.
If required by the locality, the Contractor shall be licensed by the locality. The Contractor shall provide evidence of same.

Personnel:

Project Manager: The Contractor's Project Manager assigned to this project shall have a minimum of three years continuous contracting project management experience on projects of similar size and complexity. The Project Manager shall have the authority to act for the Contractor, shall serve as the technical liaison between the Contractor and the Engineer, shall represent the Contractor at all meetings, shall be responsible for supervision of all work required to execute the Contract, shall review and approve all submittals prior to submission, and shall be present at the job site during final inspection. The Contractor shall provide a resume for the Project Manager which shall include:

A summary of the Project Manager's experience, including education, with emphasis on key skills relating to project management and the technical aspects of the systems for which the Project Manager will have responsibility.
A listing of continuous projects (with dates) over the past three years on which the Project Manager performed project management duties. Project information shall include:

Project name and location
Construction cost

A brief description of the project and the components involved
Contact names, phone numbers, and addresses
Date completed

Foreman: The Contractor's Foreman assigned to this project shall have a minimum of three years continuous supervision experience on projects of similar size and complexity. The Contractor shall provide a resume for the Foreman which shall include:

A summary of the Foreman's experience, including education, with emphasis on key skills relating to installation supervision and the technical aspects of the systems for which the Project Foreman will have responsibility.
A listing of continuous projects (with dates) over the past three years on which the Foreman performed supervisory duties. Project information shall include:

Project name and location
Construction cost
A brief description of the project and the components involved
Contact names, phone numbers, and addresses
Date completed

Employee Certification: Contractor personnel directly involved with the supervision, installation, testing, and certification of the system shall be trained and certified by the major component Manufacturer(s). The Contractor shall provide evidence of same.

Systems Specific Qualifications: Additional Contractor Qualifications are required for each system as follows:

Communications Cabling System:

The Contractor shall be completely familiar with and have extensive working knowledge of the TIA standards for telecommunications systems, the design and installation practices as defined in the BICSI Telecommunications Distribution Methods Manual, and the installation practices as defined in the BICSI Telecommunications Cabling Installation Manual. The Contractor shall provide a signed statement stating same.
RCDD: The Contractor shall assign an RCDD (Registered Communications Distribution Designer) to the project. The RCDD shall be a permanent member of the Contractor's staff (i.e. an RCDD consultant/sub-contractor to the Contractor is not acceptable) and shall be in current good standing with BICSI. The Contractor shall provide the name of and evidence of certification for the Contractor's RCDD to be assigned to the project.
Manufacturer Certification: The Contractor shall be trained and certified by the specified communications cabling system Manufacturer to install, test, and maintain the communications cabling system, shall be certified by the Manufacturer to provide the Manufacturer's most comprehensive performance and product warranty per the requirements of Division 27 Specification Section *Warranty* and it's related sub-sections, and shall be certified by the Manufacturer to provide this warranty in the location in which the work is to be performed. The Contractor shall provide evidence of same.

The Contractor shall be Manufacturer Certified as one or more of the following:

CommScope UNIPRISE BusinessPartner.
Corning Extended Warranty Program (EWP) Certified Installer.

Employee Certification: Contractor personnel shall be trained and certified by the Manufacturer as follows. The Contractor shall provide evidence of same:

Project Foreman and Supervisors: All (100 percent) shall be trained/certified by the Manufacturer for design, installation and testing.
Technicians (responsible for testing, termination, connectorization, and determination of pathway/routing, and technical labor): All (100 percent) shall be trained/certified by the Manufacturer for installation and testing.
Installers (responsible for cable installation, non-technical labor, etc.): Not required (subject to the requirements of the Manufacturer's warranty and that of the next paragraph). However, these technicians must be directly supervised by a certified Installation Technician in an on site ratio of not less than one Manufacturer certified Installation Technician per two non-certified installers.
Overall, at least 30 percent of installation personnel shall be BICSI Registered Telecommunications Installers or have an equivalent Manufacturer's certification. Of that number, at least 15 percent shall be registered at the Technician's Level, at least 40 percent shall be registered at the Installer Level 2, and the balance shall be registered at the Installer Level 1.
Other personnel: Personnel not directly responsible for installation supervision, installation, testing or certifying the communications cabling system (i.e. project managers, cleanup crew, etc.) are not required to be manufacturer trained and certified.

Security System(s):

Programmer Certification: The Contractor shall have Manufacturer certified programmers for all equipment requiring programming. The Contractor shall provide evidence of same.
In-House Capabilities: The Contractor shall have in-house capabilities and facilities for rack assembly, shop fabrication, and programming. The Contractor shall provide a signed statement stating same.
Product Dealer Information: Provide a list of manufacturers/products for which the Contractor is a Dealer. Provide the duration of the relationship and the extent of manufacturer/product training.

Electrical For Communications Systems:

Refer to Division 26 for Electrical Contractor requirements.

1.4 STATEMENT OF QUALIFICATIONS (SOQ)

The Contractor shall prepare a Statement of Qualifications which shall include all documentation verifying compliance with the requirements of and as called for in *Part 1 – General: Contractor Qualifications* herein. The Statement of Qualifications shall include, at a minimum:

General:

Governing Requirements Statement
Design and Installation Practices Statement
Contractor Project References
Contractor Service Department References

Evidence of Manufacturer(s) Certification
Office locations and information
Service Department Statement
Evidence of licensing, bonding, and insurance
Project Manager Resume
Foreman Resume
Evidence of Manufacturer(s) Training/Certification for those personnel for which training/certification is required.

Systems Specific Statement of Qualifications: There are additional SOQ requirements for each system. The Contractor shall include the following system specific documentation within the Statement of Qualifications specified above:

Communications Cabling System:

TIA Standards and BICSI Practices Statement
Evidence of certification for the Contractor's RCDD assigned to the project
Evidence of Manufacturer(s) Certification and Warranty
A list of personnel to be assigned to the project, the type of work they will be performing, and evidence of Manufacturer(s) Training/Certification for those personnel for which training/certification is required.

Security System(s):

Evidence of Programmer Certification
In-house Capability Statement
Product Dealer Information

Electrical For Communications Systems:

No additional information is required.

A Statement of Qualifications that is incomplete or does not clearly demonstrate that the qualification requirements have been met shall be rejected

1.5 SUBMITTALS

Provide the following per the criteria set forth in Submittals in Division 27 Specification Section *Basic Communications Requirements*:

Other Information:

Provide a Statement of Qualifications for each Contractor and for each system to be provided by the Contractor.

PART 2 - MATERIALS

2.1 THIS SECTION NOT USED

PART 3 - EXECUTION

3.1 THIS SECTION NOT USED

END OF SECTION 27 00 20

SECTION 27 00 30
BIDDING

PART 1 - GENERAL

1.1 SUMMARY

This Section provides requirements for bidding, including a format and definitions for the presentation of pricing for the base bid, and where applicable, alternate bid(s) and unit pricing. The contents of this Section are intended to establish pricing breakdowns which are useful to the Owner and the Engineer for evaluating bid responses.

Information as called for in this Section shall be provided per the requirements of the General Provisions of the Contract, Bidding Documents, Contract Forms, General Conditions, and the Construction Documents.

1.2 BASIS OF BID

The Contractor shall determine all existing conditions affecting the work, the type of construction to be used, and the nature and extent of work provided by other trades. Failure to do so shall be construed as willingness to provide complete and fully operational system(s) within the amount bid by the Contractor.

The Contractor shall notify the Engineer a minimum of ten (10) days prior to the bid date in the event of any of the following circumstances:

- Required items or details have been omitted from the Construction Documents
- Discrepancies or conflicts between the requirements of the Drawings and the Specifications, between the Governing Requirements and the Construction Documents, and between the various Governing Requirements.
- Discrepancies or conflicts between the requirements of this Division (27) and those of Division 0 or Division 1.

Where omissions, discrepancies, or conflicts are not brought to the attention of the Engineer, it shall be assumed that the most stringent requirement(s) constitute the basis for the Contractor's bid, and as such shall be construed as willingness by the Contractor to provide complete and fully operational system(s) within the amount bid.

Fees for necessary or required licenses, permits, and inspections shall be included in the bid amount.

Bids shall be based on products, materials and methods of construction as specified. Bids based upon substitution of product and materials, as well as deviations from the methods of construction specified, shall be at the sole risk of the Contractor and as such are subject to rejection without consideration at the time of submittal review – should the Contractor be awarded the contract.

If the bidder proposes to sub-contract portions of the work, sub-contractors shall be identified and their Statement of Qualifications (per Division 27 Specification Section *Contractor Qualifications*) submitted as part of the Bidder's bid submission.

- The Contractor is responsible for any and all work performed by a sub-contractor, and shall provide direct and continuous supervision of the sub-contracted work. Furthermore, this clause applies to any work provided by the Manufacturer(s) for equipment installation at the Contractor's request.

By submitting a Bid, the Contractor agrees:

To honor the Contractor's Bid for 90 days subsequent to the date that bids are opened.
To enter into and execute a Contract, if awarded, and to furnish all bonds and insurance required by the Contract Documents.
To accomplish the Work in accordance with the Contract Documents.
To complete the Work within the schedule stipulated by the Contract.
That the Owner reserves the right to:

Adopt all or any part of the Bidder's proposal.
Reject any or all bids received.
Withhold the award of the Contract or otherwise choose to not award the Contract.
Waive or decline to waive any informality or irregularities in any bid response received.
Select the Bidder the Owner deems to be most qualified to fulfill the needs of the Project. The lowest cost proposal will not necessarily be the proposal deemed to be the most qualified – factors in addition to cost will be used to determine the most qualified proposal.

1.3 BID FORMAT

The Bid shall contain the following mandatory documentation. Bids submitted without this documentation (in whole or in part) may be rejected without review. The documentation shall be provided in addition to any forms/documents required by the General Provisions of the Contract and/or the contracting authority.

Statement of Qualifications: Provide per Division 27 Specification Section *Contractor Qualifications* and/or its sub-sections.
Bid Form: A bid form summarizing the Contractor's bid as required by the General Provisions of the Contract and/or the Contracting Authority.
Additional Information:

Subcontractor Identification: Identify sub-contractors and their responsibilities. Submit their Statement of Qualifications per Division 27 Specification Section *Contractor Qualifications* and/or its sub-sections.
Bill of Materials (BOM): The BOM shall include each item individually priced, and shall reflect any and all required modifications, accessories, and labor for the item. Each item listed shall be complete with the following information:

Description
Part number (if applicable)
Quantity included in bid
Material cost (including all required modifications, accessories and incidental materials)
Labor cost to install (if applicable)
Total installed price

Bid Bond: Provide documentation/certificate verifying same
Performance Bond: Provide documentation/certificate verifying same

1.4 ALTERNATE PRICING

An Alternate is an amount proposed by the Contractor and stated on the Bid Form for certain work defined in the Construction Documents that may be added to or deducted from the Base Bid amount.

The cost or credit for an alternate is the net addition to or deduction from the Base Bid to incorporate the alternate into the work.
Alternate pricing shall include all costs of related coordination, modification, or adjustment of the work to accommodate and completely integrate the Alternate into the project, and shall include all necessary materials, labor, delivery, insurance, applicable taxes, overhead, markups and profit.

1.5 UNIT PRICING

Unit pricing is a price per unit of measurement for materials, equipment and/or labor added to or deducted from the Contract Sum by appropriate modification. Unit pricing is to be provided for common items which may be added or deleted during the course of construction.

It is the intent that components added by unit price during construction shall result in complete and operable components ready for the Owner's use. It is further the intent that components deducted by unit pricing shall not adversely impact the remaining or adjacent work.
Unit prices shall include all costs of related coordination, modification, or adjustment of the Work to accommodate and completely integrate the component into the project, and shall include, but shall not be limited to, all necessary materials, labor, programming, incidentals, delivery, insurance, applicable taxes, overhead, markups and profit.
Unit pricing shall remain in effect until Final Acceptance.

Provide unit prices for the addition/deduction of the items specified below. Unit pricing is broken out by the system(s) to which they pertain.

Communications Cabling:

Horizontal Outlet: Cable, faceplate, connectors (station and patch panel), terminations, incidental materials, testing, labeling, etc. for any location (regardless of distance from the Telecommunications Room). Provide pricing by outlet type and port quantities as follows:

Prior to walls covered and ceiling installed:

2-port

After walls covered and ceiling installed:

2-port

Wireless Access Enclosure: One enclosure, including and all incidental materials for hanging and support, installed.

Security:

Controlled Door <TYPE>
Card Reader
Pan-Tilt-Zoom Camera <TYPE>
Fixed Camera <TYPE>

Electrical:

Outlet Box and Raceway: One recessed single gang opening, 4-11/16 inch by 4-11/16 inch by 2-1/8 inch deep outlet box at the horizontal outlet location with conduit raceway from the outlet box location to:

Stub to accessible ceiling space

PART 2 - MATERIALS

2.1 THIS SECTION NOT USED

PART 3 - EXECUTION

3.1 THIS SECTION NOT USED

END OF SECTION 27 00 30

SECTION 27 00 40
WARRANTY

PART 1 - GENERAL

1.1 SUMMARY

This Section defines general warranty requirements for the Communications System(s).

1.2 GENERAL

Warranty

The Contractor shall warrant the Work against all defects in materials, equipment and workmanship in compliance with the applicable requirements of Division 1.
Manufacturer Warranties: The Contractor's Warranty shall include all Manufacturer Warranties. The Contractor shall represent and act on the Owner's behalf in any and all Manufacturer warranty/replacement proceedings.
Manufacturer Support Contract(s): The Contractor shall provide any manufacturer backed maintenance, warranty and/or technical support contract necessary for the Contractor to configure, operate, service, repair and/or replace any component of the Communication System(s). The contract shall be valid for the duration of the warranty period. The Contractor shall purchase the contract in the Owner's name and provide documentation and renewal information to the Owner at acceptance testing.
The Contractor shall comply with the Submittal portions of Division 27 Specification Section *Basic Communications Systems Requirements.*
All labor, materials, equipment, and other costs and services necessary for the fulfillment of the Warranty shall be provided at no charge to the Owner.

Warranty Period

Unless otherwise noted, the minimum Warranty Period shall be 1 year or as otherwise called for in the General Provisions of the Contract.
The Warranty Period shall commence upon Final Acceptance.
Manufacturer Warranties:

The Contractor shall honor Manufacturer Warranties for the full term established by the Manufacturer when said term is greater than the Warranty Period.
In cases where Manufacturer Warranties are less than the Warranty Period, the Contractor is liable for and shall warrant the Manufacturer's equipment for the entire term of the Warranty Period.
Where the Contractor has modified equipment, the Manufacturer's warranty may be voided. In such cases, the Contractor shall warrant the Manufacturer's equipment for a term equivalent to that of the original Manufacturer Warranty term, or for the entire Warranty Period, whichever is greater.

Warranty Certificate

The Contractor shall provide a written Warranty Certificate on the Contractor's letterhead, signed by the Contractor, with terms and conditions of the Warranty complying with the requirements detailed herein.
The Warranty Certificate shall include copies of all Manufacturer Warranties.
Manufacturer Warranties shall be activated by the Contractor in the Owner's name.
The Warranty Certificate shall be submitted as part of the O&M Manual submission.

Warranty Fulfillment

The Contractor shall provide a Warranty service visit within 24 hours of notification. Defects shall be remedied within 72 hours of notification.

1.3 SYSTEM SPECIFIC

The Contractor shall include the following additional system specific items as part of the Warranty above:

Communications Cabling System:

Communications Cabling System Manufacturer Warranty: The Contractor shall provide a Communications Cabling System extended product, performance/application, and labor Manufacturer Warranty that shall warrant all passive components used in the communications cabling system. Additionally, this Warranty shall cover all components not manufactured by the Manufacturer, but approved by the Manufacturer for use in the Communications Cabling System (i.e. “Manufacturer Approved Alternative Products”).

The Manufacturer Warranty shall warrant:

That the products will be free from manufacturing defects in materials and workmanship.
That all cabling products of the installed system shall exceed the specification of TIA 568 performance standards. For copper based cabling products, the TIA 568 Category rating of the specified system shall be exceeded.
That the installation shall exceed TIA 568 installation standards.
That the system shall be application independent and shall support both current and future applications that use the TIA 568 component and link/channel specifications for cabling.
That all labor and materials and other costs attributable to the fulfillment of the Manufacturer Warranty shall be provided at no additional cost to the Owner.

The Manufacturer Warranty shall be:

CommScope UNIPRISE 20-Year Product and Applications Warranty, or
Corning 25-Year LANScape Solutions Extended Warranty, or

Manufacturer Warranty Period:

The Manufacturer Warranty Period shall commence upon Final Acceptance or a Warranty Certificate being issued by the Manufacturer, whichever is later.

Manufacturer Warranty Certificate:

The Manufacturer Warranty Certificate shall be included with the Contractor Warranty.

Security System(s):

Replacement: Defective components which cannot be serviced within five business days due to unavailability of parts or services shall be replaced with new, identical components. If new and identical components are not available, the Contractor may provide new and equal substitutes upon Owner approval. Replaced components shall become the property of the Owner, and shall be warranted by the Contractor for the remaining term of the Warranty Period, or the term of Manufacturer's Warranty, whichever is longer.
Preventative Maintenance: The Contractor's Warranty shall include 2 preventative maintenance visits during the Warranty Period for the purposes of verifying equipment operation, cleaning and lubrication, minor modifications to programming, adjustment and alignment of equipment, and other services as necessary and as requested by the Owner.

The Contractor shall submit a written summary of the maintenance work performed during each Preventative Maintenance visit within five business days of the visit.

Exclusions: Fuses and exterior finishes are specifically excluded from the Warranty, except where failure or damage is attributable to defective materials or workmanship.

Electrical For Communications Systems:

No additional warranty items required.

PART 2 - MATERIALS

2.1 THIS SECTION NOT USED

PART 3 - EXECUTION

3.1 THIS SECTION NOT USED

END OF SECTION 27 00 40

SECTION 27 00 50

QUALITY ASSURANCE

PART 1 - GENERAL

1.1 SUMMARY

This Section defines processes and procedures for quality assurance applicable to Division 27.

1.2 GENERAL QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

Design Intent Meeting

The Contractor shall schedule and attend a meeting to review the design with the Engineer, Owner, and the General Contractor. The purpose of the meeting will be to ensure that the Contractor fully understands the design intent as detailed in the Contract Documents. The Contractor shall thoroughly review the Contract Documents prior to the meeting, and shall document questions, comments, and/or concerns to be discussed at the meeting. The meeting shall take place prior to Submittal preparation and submission. Attendees shall include:

Communication Systems Contractor(s)

Communications Cabling System
Security System(s)
Others as applicable

Electrical Contractor
General Contractor
Engineer
Owner

Pre-installation Meeting

Prior to beginning work in a given area (or areas), the Contractor shall schedule and attend a pre-installation meeting to review and coordinate work within that area with the other trades. The purpose of the meeting will be to review the communications pathway/raceway layout and identify and resolve any potential conflicts, to have each trade verify that the pathway/raceway sizing is sufficient for the cabling to be installed within, to ensure a consistent installation for all cabling, to minimize interference with adjacent materials and equipment, and to ensure that communications cabling and equipment is accessible to the Owner for future modifications and maintenance. The meeting shall take place a minimum of 30 days prior to communications pathway/raceway rough-in. Attendees shall include:

Communication Systems Contractor(s)

Communications Cabling System
Audiovisual System
Security System(s)
Others as applicable

Electrical Contractor
General Contractor
HVAC/Mechanical Contractor
Plumbing Contractor
Engineer

Owner

Inspections

The Contractor shall schedule and coordinate all inspections of the work as required by the Governing Authorities. The Contractor shall be solely responsible for scheduling inspections by the Governing Authorities at times appropriate to the stage of construction and the work to be inspected. The Contractor shall provide all assistance as required by the inspector(s) during their inspection(s).

Should the Governing Authorities require remedial action on the Contractor's part due to the failure of the Contractor to schedule inspections at appropriate times, such work shall be at no additional cost to the Owner.
The Contractor is solely responsible for scheduling inspections such that, should the work fail inspection, enough time remains in the project schedule to take remedial action and re-inspect the installation.

Observation of Work

Work will be observed by the Engineer on a periodic basis. Work not found to be in compliance with the Construction Documents, or not in compliance with the intent of the Construction Documents, shall be brought into compliance at no additional cost to the Owner.
The Contractor shall notify the Engineer at least one week in advance of the covering of concealed work so that the Engineer may schedule on-site observation of the work to be concealed. Work shall not be concealed until work has been tested (if applicable), observed by the Governing Authorities (if applicable), and at the Engineer's discretion, observed by the Engineer. Should work be concealed prior to such testing and observation, it shall be uncovered, tested, observed, and restored by the Contractor to the finished condition at no additional cost to the Owner.

Coordination

The Contractor shall thoroughly examine the Construction Documents, including Drawings and Specification Sections of other Divisions, shop drawings, or where equipment has been substituted or is proposed to be substituted for construction details and methods that are dependent upon or will affect the work of other trades. The Contractor is responsible for identifying coordination issues, discrepancies, conflicts and dependencies, and for preparing Shop Drawings, work plans and schedules to accommodate or mitigate coordination issues, discrepancies, conflicts and dependencies before they arise. Changes necessitated by the failure of the Contractor to coordinate with the work of other trades shall be at no additional cost to the Owner.
The Contractor shall confer and cooperate with the other trades, throughout the entire construction process, in order to coordinate the work in the proper sequence. Typical coordination issues include but are not limited to:

Electrical work, including but not limited to electrical receptacles, power panels, transformers, the telecommunications grounding system, and the installation of raceway, device boxes, conduits, cable tray, ladder racking and sleeves.
Mechanical work, including but not limited to HVAC systems and ductwork, piping, and mechanical chases.
Ceiling cavity spaces.
Installation of acoustical ceiling tiles and similar finishes that may conceal the work.
Build-in of oversized equipment during structure construction.
Required separation distances.
Access routes for equipment through the construction.

Cutting/coring of floor, ceiling or wall structures.

Verify that the physical dimensions of each item of equipment fit the available space, promptly notify the Engineer with documentation of any potential conflicts, and await the Engineer's direction prior to purchase and rough-in of the equipment. Documentation shall include narrative explanation of potential conflict supported by drawings illustrating such with suggested solution.

Coordinate locations of devices with field conditions, unless such locations are specifically dimensioned or otherwise noted in the Construction Documents. If so noted, verify location with other affected trades and against existing field conditions, promptly notify the Engineer of any potential conflicts, and await the Engineer's direction prior to purchase and rough-in of the equipment.

Coordinate locations for chases, slots, sleeves, and openings in the building structure. For new concrete coordinate, locate and provide chases, slots, sleeves, and openings prior to the pouring of the concrete.

Outages shall be coordinated and scheduled in advance with the Owner at a time and duration acceptable to the Owner. Outages scheduled at times other than the normal working hours shall not entitle the Contractor to additional compensation beyond the original amount bid. Outages without advance notice and prior approval by the Owner are not acceptable.

Furniture and Casework: Prior to procurement and installation of materials and equipment within furniture and casework, the Contractor shall coordinate with other trades and verify all locations, pathway requirements, etc. Materials and equipment installed in furniture and casework without prior coordination are solely at the Contractor's risk, and as such, are subject to possible rejection by the Engineer. Rejected materials and equipment shall be replaced and modified furniture and casework shall be restored to its original condition at no additional cost to the Owner.

Verification and Validation

Measurements

The Contractor shall physically verify and validate all measurements on site (i.e. actual measurements vs. those of the Drawings). Where discrepancies exist which could affect the Work or the Intent of the Construction Documents, the Contractor shall notify the Engineer and await the Engineer's direction, prior to procurement and installation of materials.

Raceway/Pathway Sizes

Prior to procurement and installation of raceway/pathway, the Contractor is responsible for verifying and validating raceway/pathway (conduit, sleeves, cable tray, surface raceway, etc.) sizes with any and all trades which will make use of them.

The Contractor, in conjunction with the various trades, shall determine the quantity, types, and outside diameters of the cables to be installed within each raceway/pathway, and shall verify the cable fill ratios for each pathway based upon this information. The cable fill ratios shall include spare capacity as required elsewhere within these Specifications or on the Drawings.

Where the calculated cable fill ratios exceed that recommended by the NEC and TIA 569, where the ratios indicate that the raceway/pathway is of insufficient size, and/or where discrepancies exist between the raceway/pathway sizes shown on the Drawings and the Contractor's calculated sizes, the Contractor shall notify the Engineer and await the Engineer's direction prior to procurement and installation of the raceway/pathway or cable.

Equipment locations

Prior to the installation of equipment, the Contractor shall coordinate with other trades and subsequently verify all equipment locations that mount on walls or within ceilings. This work shall include but shall not be limited to:

Structural elements such as lighting devices, HVAC equipment, fire protection devices, and cable tray.
Structural support elements for ceiling mounted devices such as but not limited to speakers, cameras, projectors and projection screens.
Backing Board for wall mounted devices such as but not limited to equipment panels, equipment panels, power supplies, head-end equipment, flat panel displays, speakers, and equipment room devices.

No additional compensation will be approved for additional work or materials required due to the Contractor's failure to verify and validate the above.

Examination

The Contractor shall carefully examine the project site and the Construction Documents and shall be responsible for identifying all utility, state, and local requirements that will affect the Work.
The Contractor shall become familiar with the local conditions under which the work is to be performed and correlate those conditions with the requirements of the Construction Documents. No allowance will be made for claims of concealed conditions which the Contractor, exercising reasonable due diligence while examining the site, observed or should have observed.
The Contractor shall be responsible for determining if the Work will affect the operation or code compliance of existing systems. Where this is the case, the Contractor shall notify the Engineer and await the Engineer's direction prior to procurement and installation.

1.3 SYSTEMS SPECIFIC QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

In addition to the quality assurance processes and procedures specified above, the Contractor shall provide the following for each system:

Communications Cabling System:

Coordination:

The Contractor shall review the Drawings and Specifications of other Divisions for locations of devices and equipment requiring communications connectivity not specified or shown on the Drawings of this Division. The Contractor shall coordinate the locations of these items with the other trades, and shall verify locations with the Engineer and Owner prior to rough-in.
The Contractor shall facilitate and coordinate Service Providers installations with the Owner and with the Service Provider(s).

Verification: The Contractor shall physically verify the following on site, prior to procurement and installation:

Backbone Cable: Verify total run lengths for each backbone cable (inside and outside plant) from origination to destination using the pathways provided (ductbank, conduits, raceway, conduit, cable-tray, sleeves, open/accessible pathways, etc.), and including slack loops, vertical transitions, jogs, etc. Pre-cut cables of insufficient length are the sole responsibility of the Contractor.
Station Cable: Verify total run lengths for each station cable from outlet location to communications room using the pathways provided (conduit, cable tray, sleeves, open pathways, etc.), and including slack loops, vertical transitions, jogs, etc. For run lengths which may exceed 270 feet, the Contractor shall obtain the Engineer's direction prior to proceeding with the installation.

Contractor RCDD Periodic Review:

During the course of construction, the Contractor's RCDD shall periodically perform an on-site review of the construction in progress and certify that the construction conforms to the requirements of the Governing Requirements, and in particular the TIA standards. The RCDD shall provide a written report to the Owner/Engineer on company letterhead that details the work reviewed and states that the work is in conformance with the Governing Requirements. The work in progress shall be reviewed and a report delivered to the Owner/Engineer on a bi-weekly basis.

Inspections:

Inspections shall occur no later than one week after Substantial Completion. Furthermore, inspections shall be completed and certified no later than three weeks prior to the scheduled use of the system by the Owner.

Manufacturer Inspection: The installation is required to pass all Manufacturer certification requirements.

i. The completed installation shall be inspected by Manufacturer personnel, shall pass the Manufacturer inspection, and shall be certified by the Manufacturer to meet and be covered by the Manufacturer extended product warranty.
ii. The Contractor is solely responsible for all costs associated with scheduling the Manufacturer inspection, the inspection itself, and for making any modifications to the installation as required by the Manufacturer at no additional cost to the Owner.

RCDD Inspection: The installation is required to comply with the Governing Requirements.

i. The Contractor's RCDD shall inspect the completed installation and prepare a certificate on company letterhead certifying that the work complies with the Governing Requirements. The written certification shall be complete with the RCDD's stamp/certification number and shall bear the RCDD's signature across the face of the stamp. The certification shall be submitted with the O&M documentation.

Security System(s):

Equipment locations: Prior to installation of equipment, the Contractor shall coordinate with other trades and subsequently verify all equipment locations that mount on walls or within ceilings. This work shall include but shall not be limited to:

Structural elements such as lighting devices, HVAC equipment, fire protection devices, and cable tray.
Structural support elements for ceiling mounted devices.
Backing Board for wall mounted devices such as equipment panels, power supplies, head-end equipment, etc..

Low Voltage System(s):
Electrical (for Communications Systems)

Raceway/Pathway Size Validation: The Electrical Contractor is responsible for ensuring that the Raceway/Pathway sizes have been validated by all trades per the criteria set forth in *Part 1 – General: General Quality Assurance/Quality Control (QA/QC), Verification and Validation, Raceway/Pathway Sizes* above.

Where discrepancies exist between the raceway/pathway sizes shown on the Drawings and the Contractor’s calculated sizes, the Contractor shall notify the Engineer and await the Engineer's direction prior to procurement and installation of the raceway/pathway.
Materials

PART 2 - MATERIALS

2.1 THIS SECTION NOT USED

PART 3 - EXECUTION

3.1 THIS SECTION NOT USED

END OF SECTION 27 00 50

SECTION 27 00 60
TRAINING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section defines training requirements for the various communications systems.

1.2 GENERAL REQUIREMENTS

A. Trainer/Instructor

1. The Instructor leading the training session(s) shall be a qualified and experienced trainer. Where the Contractor does not have a qualified and experienced trainer on staff, the Contractor shall arrange to have appropriate Manufacturer Representative(s) lead the training session(s).
2. The Contractor shall have the Project Manager and/or Foreman present during the training session(s) in order to assist the Instructor by providing “hands-on” operational knowledge of the installation and operations of the systems.
3. For complex/sophisticated equipment, the Contractor shall arrange to have the appropriate Manufacturer Representatives present during the training session(s).

B. Schedule and Location

1. The date and time of the training sessions(s) shall be coordinated with and approved by the Owner and Engineer. The Engineer may attend the training session(s) at the Engineer’s discretion.
2. The training sessions(s) shall occur within one month of Substantial Completion, unless otherwise approved by the Owner.
3. Training session(s) shall occur at the site, in order to provide the participants with “hands-on” experience.
4. Training may not necessarily occur in contiguous periods, depending upon the needs of the Owner (e.g. if a total of 8 hours of training is required, depending upon the needs of the Owner, it may be that two 2-hour periods and one 4-hour period spread across several weeks may be necessary).

C. Follow-up Training

1. Unless otherwise noted, provide one follow-up training session during the Warranty Period, scheduled at the request of the Owner. The follow-up training session shall occur after the Owner has had the opportunity to fully operate the system(s). The Contract shall not be considered complete until training has been completed.

PART 2 - MATERIALS

2.1 GENERAL

A. The final version of the O&M Manual(s) shall be used as the primary training aid.

B. Training materials and presentations shall be professional in appearance, organized, bound, and suitable for re-use by the Owner in the future. Provide training materials to each participant, plus an additional 10 copies to the Owner for future use. Training materials shall be provided on CD-ROM in addition to hardcopy.

C. Recording

1. Unless otherwise noted, the Contractor shall schedule, arrange, and provide equipment and personnel to **professionally record** the Training session(s), and shall provide the subsequent recording to the Owner in standard DVD or Blu-ray format as well as electronically in MPEG4 format.

PART 3 - EXECUTION

3.1 GENERAL

A. The Contractor shall provide training on the proper operation and routine maintenance of the various communications systems. Training shall include “hands-on” demonstrations.

B. Training shall not commence until the communications system(s) are complete, tested, and fully operational.

3.2 TRAINING

A. Provide training for each system as follows:

1. Communications Cabling System:

a. Training Session(s)

1) Provide a total of 8 hour(s) of training, broken out approximately as follows:

a) Overview of the Communications Cabling System and Warranty process: Provide 1 hour(s) of training
b) Backbone Cabling: Provide 1 hour(s) of training
c) Horizontal Cabling: Provide 2 hour(s) of training
d) Communications Rooms and Spaces: Provide 3 hour(s) of training
e) Other: 1 hour(s)

b. Videotaping: Not required.
c. Follow-up Training: Not required.

2. Security System(s):

a. Training Session(s)

1) Provide a total of 16 hour(s) of training, broken out approximately as follows:

a) Overview of the Security System(s) and Warranty process: 2 hour(s)
b) Master control room: 4 hour(s)
c) Security Cameras/Surveillance: 2 hour(s)
d) Access Control System: 2 hour(s)
e) Other: 4 hours(s)

b. Follow-up Training Session: Provide one 2 hour session.

3. Electrical For Communications Systems:

a. Not required.

END OF SECTION 27 00 60

SECTION 27 04 05

COMMON WORK - SLEEVES, PENETRATIONS, AND FIRESTOPPING

PART 1 - GENERAL

1.1 SUMMARY

This Section includes specific requirements for sleeves and penetrations common to the communications systems.

1.2 RELATED SECTIONS

The firestopping requirements of this Section are additional to, different from, or otherwise supplement the Section(s) in Division 7 which pertain(s) to thermal protection systems, such as firestopping and fire-resistive materials. The applicable requirements of these Section(s) shall serve as the basis for the requirements of this Section, and are incorporated by reference into this Section.

1.3 SUBMITTALS

Provide the following per the criteria set forth in Submittals in Division 27 Specification Section *Basic Communications Requirements*:

Product Data
Other

Submit locations where new penetrations are required in existing structural concrete walls, parapets, and suspended slabs.
Submit locations where new penetrations are required in existing roofs and roofing materials.

1.4 DEFINITIONS

EMT: Electrical Metallic Tubing

RMC: Rigid Metal Conduit

PART 2 - MATERIALS

2.1 GENERAL

Part Numbers: Refer to the Equipment Schedule(s) on the Communications Construction Drawings for specific manufacturers and part numbers. If no part number is provided, then any part meeting the manufacturer and requirements specified is acceptable.

2.2 SLEEVES

Provide sleeves for all locations where cable must pass-through building barriers such as walls, floors or foundations.

Sleeves consist of Conduit Section(s), Cable Tray Wall Penetration Sleeve Device(s), Cable Pathway Smoke and Acoustical Device(s), Cable Pathway Firestopping Device(s) or Fire Rated Floor Penetration Assemblies passing through a penetration/opening in a barrier or floor.

Conduit sections used for sleeves shall be per the requirements of Division 27 Specification Section *Electrical Technology - Conduit and Boxes.*

Sleeves through fire rated, smoke rated, and/or acoustically rated barriers shall be:

Cast-in-place: Provide:

Hilti Cast-In-Place Opening (CP 680M/P) equipped with:

Hilti Speed Sleeve (CP 653), typical; or
EMT conduit section with appropriate fill material; or

RMC conduit sections; or
As otherwise shown on the Drawings

Cored: Provide:

Hilti Speed Sleeve (CP 653) typical; or
EMT conduit sections with appropriate fill material; or
As otherwise shown on the Drawings

Smoke and Acoustic Pathway Devices/Sleeves shall be:

For non fire-rated barriers/partitions that are smoke rated or where there is an acoustical transmission concern, other than floors: Cable Pathway Smoke and Acoustic Pathway Device/Sleeve.

Devices shall be pre-manufactured enclosed Smoke and Acoustic Pathway Devices/Sleeves with a built-in air leakage and sound transmission system sufficient to maintain the ratings of the barrier being penetrated. The self-contained system shall easily re-penetrable and re-sealable, and adjustable to accommodate the installed cable loading. The device shall permit cables to be installed, removed, or maintained without the need to remove or reinstall materials. The pathway shall be UL classified, shall be L Ratings Tested According to Air Leakage Test Procedure as outlined in UL1479 without a Fire Test, Plenum tested to UL2043 in Horizontal Installations Only and Sound Transmission Classification (STC) tested per ASTM E90. Use shall be per local codes. Sleeves shall be:

Hilti: Speed Sleeve CP 653
Specified Technologies, Inc.: EZ-Path Smoke and Acoustic Pathway Device
Or approved equal

Fire-rated Sleeves shall be:

For barriers other than floors: Cable Pathway Firestopping Device

Devices shall be pre-manufactured enclosed fire rated pathway devices with a built-in fire sealing system sufficient to maintain the hourly rating of the barrier being penetrated. The self-contained sealing system shall automatically adjust to the installed cable loading and shall permit cables to be installed, removed, or maintained without the need to remove or reinstall firestop materials. The pathway shall be UL classified and FM/Systems approved, and shall be examined and tested to the requirements of ASTM E814 (UL1479). Use shall be per local codes. Sleeves shall be:

Hilti: Speed Sleeve CP 653
Specified Technologies, Inc.: EZ-Path
Wiremold: FlameStopper
Or approved equal

For Cable Pathway Firestopping Devices sizes 3-inch and larger provide a Radius Drop Guide (also known as Radius Control Module or Conduit Waterfall) for each device. Manufacturer shall be:

Panduit: Conduit Waterfall CWF400
Specified Technologies, Inc.: EZ-Path

Floor Penetration Assemblies: For penetrations through fire rated floors, provide one of the solutions described in sub-paragraphs below:

Provide a round re-penetrable re-sealable fire-rated cable management device. The fire-rated cable management device shall consist of a corrugated steel tube with zinc coating, contain and inner plastic housing, intumescent material rings, and inner fabric smoke seal membrane. The length of the sleeve shall be 12.4 inches. The fire-rated cable management device shall contain integrated intumescent firestop wrap strip materials sufficient to maintain the hourly rating of the barrier being penetrated. The fire-rated cable management device shall contain a smoke seal fabric membrane or intumescent firestop plugs sufficient to achieve the L-Rating requirements of the barrier type. The fire rated cable management device shall be:

Hilti: Speed Sleeve (CP653) with integrated smoke seal fabric membrane.
Hilti: Cast-In-Place opening (CP 680M/P)

2.3 FIRESTOPPING

General:

Provide firestopping material for all through and membrane penetrations of fire-rated barriers.
Firestopping material used to seal open penetrations through which cable passes shall be re-usable/re-enterable.
Provide through-penetration firestop products that are compatible with one another, with the substrates forming openings, and with the penetrating items.
Provide firestop products that upon curing do not re-emulsify, dissolve, leach, breakdown or otherwise deteriorate over time from exposure to atmospheric moisture, sweating pipes, ponding water or other forms of moisture characteristic during and after construction.
Provide firestop sealants sufficiently flexible to accommodate motion such as pipe vibration, water hammer, thermal expansion and other normal building movement without damage to the seal.
Materials or sealants shall not contain flammable solvents or sodium silicate.
Products specified in this Section shall be UL Listed and Labeled.

Firestopping Materials

Material 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 or UL 1479 fire test in a configuration that is representative of the actual field conditions.
Materials shall be complete with necessary accessory materials, as applicable, for complete UL listed and approved assemblies.

Firestopping materials shall be manufactured by:

Hilti
Specified Technologies. Inc.
Or approved equal

PART 3 - EXECUTION

3.1 GENERAL

Work shall comply with the Governing Requirements as defined in Division 27 Specification Section *Basic Communications Requirements*. Governing Requirements of particular relevance to this Section include, but are not limited to:

NEC: National Electrical Code (NFPA Article 70)
TIA 569: Commercial Building Standard for Telecommunication Pathways and Spaces

Installation shall be such that communications circuits, when installed in the pathways and penetrations specified herein, are able to fully comply with the following:

TIA 568: Commercial Building Telecommunications Cabling Standard

3.2 SLEEVES

Provide sleeves for all locations where free hung cable must pass through building barriers such as walls, floors or foundations.

The Contractor shall provide all cutting, rough patching and finish patching as required for the installation of sleeves, and shall provide all penetrations, including core drilling, roto-hammering, etc. as required.

Sleeves shall be sealed and firestopped (as appropriate to the fire rating of the barrier) between the conduit section (or cable pathway firestopping device) and the barrier penetration/opening.

Sleeve size shown on the Drawings reflects the size of the conduit or device passing through, not the size of the penetration/opening.

Conduit section sleeves:

Conduits shall be installed per the requirements of Division 27 Specification Section *Electrical Technology - Conduit and Boxes.*
Conduit sections shall be installed complete with insulated throat bushings.
Conduit Sleeve Sizing:

Unless otherwise noted on the Drawings, sleeve size through floors shall be 4-inch diameter, with quantity of sleeves sufficient to accommodate planned cabling, plus additional sleeve(s) to provide at least 25 percent for future expansion.
Unless otherwise noted on the Drawings or specified herein, sleeves shall be sized as follows:

Where cable trays must pass through a non-fire rated barrier. Transition from cable tray to Conduit Sleeve(s) at non-fire rated barriers.

Provide sufficient quantity of conduit sleeves such that the combined useable cross sectional area of the devices matches or exceeds the cross sectional area of cable tray to be served.

Where free hung cables must pass through non-fire rated barriers.

Provide sufficient quantity of conduit sleeves according to the quantity and outside diameter of the cable(s) they are to support per NEC fill ratios and TIA 569 cable capacity standards, plus an additional 25 percent for future expansion.

Smoke and Acoustic Pathway Device/Sleeve:

Provide Smoke and Acoustic Pathway Devices for locations where cable will penetrate through a non-fire rated barrier that is smoke rated or where there is an acoustical transmission concern such as in locations where adjacent rooms have no ceilings. Refer to architectural drawings for wall and ceiling type information.

Unless otherwise noted on the Drawings or specified herein, Pathway Device/Sleeve shall be sized as follows:

Where free hung cables must pass through a non-fire rated barrier that is smoke rated or where there is an acoustical transmission concern:

Provide sufficient quantity of Smoke and Acoustic Pathway Devices/Sleeves according to the quantity and outside diameter of the cable(s) they are to support per NEC fill ratios and TIA 569 cable capacity standards, plus an additional 25 percent for future expansion.

Cable Pathway Firestopping Device:

Where cable trays must pass through fire rated barriers. Transition from cable tray to Cable Pathway Firestopping Devices at fire rated barriers.

Provide sufficient quantity of cable pathway firestopping devices such that the combined useable cross sectional area of the devices matches or exceeds the cross sectional area of cable tray to be served.

Where free hung cables must pass through fire rated barriers.

Provide sufficient quantity of cable pathway firestopping devices such that the combined useable capacity of the devices is a minimum of 150% of the cable to be served.

Fire Rated Floor Penetration Assembly:

Provide where shown on Drawings.
Install strictly in accordance with Manufacturer's installation guide and applicable codes.

3.3 PENETRATIONS

Properly size and locate penetrations required as construction progresses. For new concrete or masonry the Contractor shall coordinate, locate and provide required openings prior to the pouring of concrete or construction of masonry.

Penetration of concrete and structural elements shall be avoided where possible. Where not possible, obtain written approval from the Structural Engineer/Architect prior to penetration. Such penetrations shall be performed in a manner that will not reduce structural element load-carrying capacity or load-deflection ratio.

Penetrations shall be performed by workers qualified and skilled in the trades involved.

Penetrations (through and membrane) of fire rated barriers shall be firestopped and sealed. The fire rating of the barrier shall be strictly maintained.

Penetrations shall not be exposed on the exterior or in occupied spaces in a manner that would, in the Engineer's opinion, reduce the aesthetic qualities of the structure or result in visual evidence of penetration and patching.

Penetrations shall be constructed using methods least likely to damage elements to be retained or adjoining construction.

Provide temporary support for the work to be penetrated.
In general, where cutting is required, use hand or small power tools designed for sawing or grinding, not for hammering or chopping. Cut holes and slots neatly to required size with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
Cut or drill from the exposed or finished side into concealed surfaces to avoid marring of existing finished surfaces.
Cut through concrete and masonry using a cutting device such as a Barborundum saw or diamond core drill.

Voids around penetrations shall be properly sealed, caulked or grouted as required.

Existing elements:

The Contractor shall be responsible for identifying, locating, and protecting existing elements such as embedded conduits, pipe, ductwork, etc. when penetrating existing structures.
Cap, valve, plug or seal remaining portions of cut pipes or conduit to prevent entrance of moisture or other foreign matter.
The Contractor shall be responsible for repairing or replacing existing conduits, pipe, ductwork, etc. damaged by the Contractor during construction of penetrations. Repair or replacement shall be made at no additional cost to the Owner.

Penetrations (and subsequent patching) resulting from the Contractor's failure to properly coordinate penetrations shall be at no additional cost to the Owner.

Penetrations shall be laid out and installed in advance to facilitate the installation of raceway through the penetrations.

3.4 FIRESTOPPING

Work shall be in accordance with the UL Fire Resistance Directory, fire test reports, fire resistance requirements, acceptable sample installations, manufacturer's recommendations, local fire and building authorities, and codes.

Application of sealing material shall be accomplished in a manner acceptable to the local fire and building authorities.

The fire rating of all penetrated fire barriers shall be strictly maintained. All through penetrations as well as membrane penetrations of fire rated barriers shall be firestopped and sealed.

Installation shall be performed in strict accordance with manufacturer's detailed installation procedures. Prepare surfaces per manufacturer's instructions. After installation, clean all surfaces adjacent to sealed openings to be free of excess firestopping materials and soiling.

Personnel installing firestopping products shall be certified by the Manufacturer to install such products.

Install firestopping in open penetrations and in the annular space of penetrations for fire rated barriers.

Seal all openings or voids made by penetrations to ensure an air and water resistant seal.

Install firestopping such that the performance and effectiveness of other thermal and fire protective devices (such as fire/smoke dampers) in the area are fully maintained.

Install putty pads in conjunction with metallic boxes where size or aggregate area of such boxes exceed limits established by the governing requirements.

Protect materials from damage on surfaces subjected to traffic.

Apply a suitable bond-breaker to prevent three-sided adhesion in applications where this condition might occur such as the intersection of a gypsum wallboard/steel stud wall to floor or roof assembly where the joint is backed by a steel ceiling runner or track.

Where joint application is exposed to the elements, fire resistive joint sealant must be approved by the manufacturer for use in exterior applications and shall comply with ASTM C-920.

Do not install firestop products when ambient or substrate temperatures are outside limitations recommended by the manufacturer.

Do not install firestop products when substrates are wet due to rain, frost, condensation or other causes.

Schedule installation of firestopping after completion of penetrating item installation but prior to covering or concealing openings.

Firestopping devices shall not act as supports.

END OF SECTION 27 04 05

SECTION 27 04 06

COMMON WORK - HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 SUMMARY

This Section includes specific requirements for hangers and supports within the Communications Pathway System. General requirements are covered in Division 27 Specification Section *Electrical Technology - General Requirements.*

1.2 RELATED SECTIONS

The requirements of Division 27 Specification Section *Electrical Technology - General Requirements* shall serve as the basis for the requirements of this Section, and are incorporated by reference into this Section.

1.3 SUBMITTALS

Provide the following per the criteria set forth in Submittals in Division 27 Specification Section *Basic Communications Requirements*:

Product Data

1.4 DEFINITIONS

Hanger/Support System: All equipment, materials, and incidentals required to support the raceway/pathway and cabling systems, including but not limited to metallic hangers and supports, conduit, cable tray, conduit, pull boxes, device boxes, u-channels, threaded rods, clamps, concrete inserts, anchor bolts, cables, backing boards, etc.

PART 2 - MATERIALS

2.1 GENERAL

Part Numbers: Refer to the Equipment Schedule(s) on the Communications Construction Drawings for specific manufacturers and part numbers. If no part number is provided, then any part meeting the manufacturer and requirements specified is acceptable.

2.2 HANGERS AND SUPPORTS

A complete Hanger/Support System shall be provided to support all components of the raceway/pathway and cabling systems.

The Contractor shall provide all materials, labor and incidentals as required for a complete Hanger/Support System.

The Hanger/Support System shall be of corrosion resistant or galvanized steel, shall be of an approved standard design, and shall be constructed to maintain the supported load in proper position and alignment under all operating conditions. Manufacturer shall be:

B-line
Caddy/Erico
Kindorf
Unistrut
or Equal

2.3 CABLE SUPPORTS (J-HOOKS, STRAPS)

Cable supports:

Provide cable supports suitable for the quantity of cables to be supported. Cable supports shall be complete with all incidental materials and assemblies required, including but not limited to mounting accessories to independently support supports from structure, extender brackets for mounting multiple hooks on a single support, clamps and fasteners, dedicated support wires, purlins and cable retainers as required. Supports, incidental materials, cable ties and cable retainers shall be plenum or non-plenum rated to match that of associated cable, and shall be listed to UL Standard 2239. Supports shall be:

Wide Base Cable Supports (J-Hooks): Supports shall be wide-based (minimum 1-inch) with flared edges. Provide larger sizes and multiple supports as required by cable quantities.

Straps/Slings: Straps/slings shall be wide-based (minimum) 2-inch and adjustable. Provide sizes, quantities and universal mounting equipment as required.

PART 3 - EXECUTION

3.1 HANGERS AND SUPPORTS

Hanger/Support system shall be installed in such a manner as to prevent any strain being imposed on the equipment supported.

Coordinate with the building structure and the work of other trades.

Install individual and multiple trapeze raceway hangers and riser clamps as necessary to support raceways. Provide all incidental materials as necessary for hanger assembly and for securing hanger rods and conduits. Use 3/8 inch diameter or larger all-thread rods for support.

NEC requirements:

Hangers and supports shall be installed at required intervals.
Conduit, hangers and supports, cable, or infrastructure related to Communications Systems, shall not be secured to, or supported by, the ceiling assembly, including the ceiling support wires. An independent (dedicated) means of secure support shall be provided.
Wires provided as dedicated hangers for supports shall be secured at both ends, such as the structural ceiling at one end and the suspended ceiling grid at the other end, and shall be distinguishable from wire used to support the suspended ceiling assembly by color, tagging, or other effective means.

In exposed structural ceiling spaces, where no suspended ceiling assembly is indicated, wire shall not be used as a hanger for supports.

Strength of each support shall be adequate to support a minimum of five times the present and future load. A minimum of 200 pound safety allowance for each support is required.

Cut threaded rods such that the bottoms have a maximum length of thread below the bottom nut equal to that of the rod diameter (i.e. a 3/8 inch rod would have a maximum length of 3/8 inches below the bottom nut).

Conduit and box support installation shall prevent displacement of conduit and box in any direction.

Provide plastic or rubber end caps for all Hanger/Support System components which are readily accessible and exposed to personnel.

Anchor Methods:

Verify all allowable Anchor Methods with the General Contractor, Owner, Structural Engineer, and Structural Construction Documents prior to performing any work. Not all methods listed below may be allowed depending on the Structural Design / Elements.

Hollow Masonry: Toggle bolts or spider type expansion anchors.
Solid Masonry (excluding concrete): Steel expansion bolts.
New Concrete: Preset inserts with machine screws and bolts.
Existing Concrete: Steel expansion bolts or explosive powder driven inserts.
Wood surfaces: Wood screws.
Steel: Welded threaded studs or galvanized steel clamps.
Light Steel: Sheet metal screws.

Firestopping devices shall not act as supports.

3.2 CABLE SUPPORTS (J-HOOKS, STRAPS)

General:

Cable supports shall be used to support cables in open access environments. Supports shall be provided along the entire pathway. Multiple supports at hanger locations shall be provided as required by the quantity of cables to be supported (subject to the maximum load which can be supported by the hanger) as well as cable segregation requirements (see below).
Cable supports may be affixed to structural members or other supports, but shall not be attached to pipes, electrical conduit, mechanical items, existing cables, or the ceiling support system. Supports shall be hung from all thread rods, dedicated #8 galvanized wires, or from brackets connected directly to structure, and shall be installed above accessible ceilings.
Where cable pathways are shown on the Drawings, the Contractor shall follow the indicated pathways as closely as possible, subject to field conditions. Pathways, where not shown, including pathways for small cable counts, shall be designed and documented on the As-built drawings maintained by the Contractor. Supports shall be installed parallel and perpendicular to building lines.
Cable supports shall be mounted at varying intervals with each interval not to exceed 5 feet. Supports shall also be placed at all changes of direction. The Contractor shall ensure that intervals between cable supports shall vary along the pathway (i.e. a given interval should not be exactly the same length as the interval preceding or following it – “exact” intervals can degrade cable performance).
Cable supports shall not support more cables than for which they were designed and shall not exceed 50 percent of the manufacturer’s recommended fill. Multiple cable supports shall be provided where the total cable fill exceeds this amount.
Installation of supports shall be fully coordinated with other elements such as mechanical ductwork, piping/plumbing, electrical conduit, and other systems such that the supports remain fully accessible after installation.
Group cabling in separate supports by the type of Communications System (Communications, Audiovisual, Security, etc.). Different systems shall not share cable supports.

END OF SECTION 27 04 06

SECTION 27 05 00

ELECTRICAL TECHNOLOGY - GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

This Section includes general requirements for raceway, pathways, grounding and bonding, and other electrical infrastructure necessary for the support of Communications Systems.

1.2 RELATED SECTIONS

The requirements of this Section are additional to, different from, or otherwise supplement similar Section(s) in Division 16. The applicable requirements of those Section(s) shall serve as the basis for the requirements of this Section, and are incorporated by reference into this Section.

Division 27 Specification Section *Common Work - Sleeves, Penetrations and Firestopping.* Provide sleeves, penetrations, and firestopping as required to support the work of this Section.

Division 27 Specification Section *Common Work – Hangers and Supports.* Provide hangers and supports as required to support the work of this Section.

Division 28 Specification Section(s) *for Security System(s)*.

1.3 SUBMITTALS

Provide the following per the criteria set forth in Submittals in Division 27 Specification Section *Basic Communications Requirements*:

Product Data
Shop Drawings:

Raceway/pathway routing plan (including underslab, underfloor, and OSP conduit/ducts):

Provide a routing if such plan has not been shown on the Drawings, or if the Contractor is proposing a deviation from that shown. The routing plan shall include:

Complete floor plans or detail drawings showing the proposed routing and raceway sizes and locations, submitted in a manner equal to that of the Construction Drawings.
A statement that the proposed routing has been coordinated with electrical, HVAC, plumbing, and other trades, and that comparable changes have been made to the cabling systems making use of the routing. Specifically note each location where the proposed routing is different from the Drawings, and the reason for the deviation.
Routing deviations must be approved in writing by the Engineer prior to proceeding with installation.

If a routing plan is not required, submit written documentation stating that:

The raceway/pathway routing will be provided as shown on the Drawings,

The Contractor has reviewed the routing shown on the Drawings with the other applicable trades and that it does not create conflicts between the trades
The raceway/pathway routing meets applicable codes, regulations and standards.

Other:

Owner Specific: Submit other information as required by Owner Specific Governing Requirements in Specification Section *Basic Communications Requirements*.

PART 2 - MATERIALS

2.1 THIS SECTION NOT USED

PART 3 - EXECUTION

3.1 GENERAL

Work shall comply with the Governing Requirements as defined in Division 27 Specification Section *Basic Communications Requirements*. Governing Requirements of particular relevance to this Section include, but are not limited to:

NEC: National Electrical Code (NFPA Article 70)
TIA 569: Commercial Building Standard for Telecommunication Pathways and Spaces
TIA 606: The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
ANSI/NECA/BICSI 607: Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings
ANSI J-STD-607: Commercial Building Grounding and Bonding Requirements for Telecommunications

Installation shall be such that communications circuits, when installed in the pathway systems specified herein, are able to fully comply with the following:

TIA 568: Commercial Building Telecommunications Cabling Standard

Unless otherwise noted on the Drawings or specified herein, communications raceway/pathways (conduit, sleeves, cable tray, surface raceway, etc.) shall be sized according to the quantity and outside diameter of the cable(s) they are to support per NEC fill ratios and TIA 569 cable capacity standards, plus an additional 25 percent for future expansion.

Firestopping: All penetrations of fire rated barriers shall be firestopped and sealed. The fire rating of all fire barriers shall be strictly maintained.

Labels/identification: Label and identify components of the pathway system per TIA 606.

END OF SECTION 27 05 00

SECTION 27 05 26

ELECTRICAL TECHNOLOGY - GROUNDING AND BONDING

PART 1 - GENERAL

1.1 SUMMARY

This Section includes specific requirements for the Telecommunications Grounding and Bonding System to provide a permanent bonding infrastructure for communications systems.

The Telecommunications Grounding and Bonding System is bonded to the building grounding system and performance is dependent upon the building grounding system – the AC Electrode Grounding System and the Equipment Grounding System specified in Division 26 *Specification Electrical – Grounding and Bonding for Electrical Systems*.

General requirements are covered in Division 27 Specification Section *Electrical Technology - General Requirements*.

1.2 RELATED SECTIONS

The requirements of Division 27 Specification Section *Electrical Technology - General Requirements* shall serve as the basis for the requirements of this Section, and are incorporated by reference into this Section.

The requirements of Division 26 Specification Section *Electrical - Grounding and Bonding for Electrical Systems* shall serve as the basis for the requirements of this Section, and are incorporated by reference into this Section.

This Section may expand upon or supplement the requirements of Division 26 Specification Section *Electrical - Grounding and Bonding for Electrical Systems*. In the event of a conflict or discrepancy between this Section and the requirements of Division 26 Specification Section *Electrical - Grounding and Bonding for Electrical Systems*, the requirements of Division 26 Specification Section *Electrical - Grounding and Bonding for Electrical Systems* shall govern and notification of such discrepancy shall be submitted to the Engineer. However, if the requirement of this Section (or portion thereof) exceeds that of the requirements of Division 26 Specification Section *Electrical - Grounding and Bonding for Electrical Systems*, and is furthermore not contrary to the requirements of Division 26 Specification Section *Electrical - Grounding and Bonding for Electrical Systems*, then the requirement of this Section (or portion thereof) shall prevail.

Detail TE-GS – Typical Grounding and Bonding System Detail located on the Communications Construction Drawings.

1.3 SUBMITTALS

Comply with the Submittal portion of Division 27 Specification Section *Basic Communications Requirements*. Provide submittal information for the following:

Product Data

1.4 DEFINITIONS

BCT: Bonding Conductor for Telecommunications: Conductor that bonds the TMGB to the AC Grounding Electrode System.

EF: Entrance Facility: Entrance to a building for both public and private network service cables. May be located in an ER or TR.

ER: Equipment Room: Environmentally controlled centralized space of telecommunications equipment. Sometimes referred to as Main Distribution Frame (MDF), Data Center (DC), or server room.

GE: Grounding Equalizer: Bonding conductor that bonds TGBs on the same floor of a structure.

TBB: Telecommunications Bonding Backbone: Bonding conductor that bonds the Telecommunications Main Grounding Busbar to one or more Telecommunications Grounding Busbars.

TE: Telecommunication Enclosure: Floor or tenant serving space (enclosure or cabinet) that provides a connection point between backbone and horizontal infrastructures. Sometimes referred to as an Intermediate Distribution Frame (IDF) or Floor Distributer (FD).

TEBC: Telecommunications Equipment Bonding Conductor: Bonding conductor that bonds all non-current carrying metal telecommunications equipment and materials to the nearest TGB or TMGB.

TGB: Telecommunications Grounding Busbar: Busbar used to connect TEBCs and TBBs in a specific room. TGB is generally connected (bonded) to building structural steel, the nearest low-voltage electrical distribution panel and to the Telecommunications Main Grounding Busbar via the TBB. There is typically one (possibly more) Telecommunications Grounding Busbar per telecommunication room or equipment room.

TMGB: Telecommunications Main Grounding Busbar: Busbar bonded to the electrical service ground (Intersystem Bonding Termination). Origination of the TBB. There is typically one Telecommunications Main Grounding Busbar per building, located in near the communications entrance facility (EF) or in the main telecommunications room (MDF) or Building Distributer (BD).

TR: Telecommunication Room: Floor or tenant serving space that provides a connection point between backbone and horizontal infrastructures. Sometimes referred to as an Intermediate Distribution Frame (IDF) or Floor Distributer (FD).

PART 2 - MATERIALS

2.1 GENERAL

Manufacturer: Communications grounding and bonding equipment and materials shall be manufactured by a single Manufacturer unless specifically stated otherwise. The manufacturer shall be:

Chatsworth Products, Inc. (CPI)
Erico
Cooper B-Line

Part Numbers: Refer to the Equipment Schedule(s) on the Communications Construction Drawings for specific manufacturers and part numbers. If no part number is provided, then any part meeting the manufacturer and requirements specified is acceptable.

Labels/Identification: Provide labels to identify of all components of the communications grounding and bonding system. Labels shall be permanent (i.e. not subject to fading or erasure) and permanently affixed. Handwritten labels are not acceptable.

Equipment and materials in this Section shall be UL Listed and Labeled.

2.2 GROUNDING BUSBARS

Grounding busbars shall meet the specifications of ANSI/NECA/BICSI 607 and ANSI J-STD-607 and conform to BICSI recommendations, with standard NEMA bolt hole sizing. Grounding busbars shall be predrilled copper busbars plated for reduced contact resistance and have minimum dimension of 1/4 inch thick by width and length listed below:

Telecommunications Main Grounding Busbar (TMGB): TMGBs shall be a minimum of 4 inches wide and have a minimum length of 20 inches. Provide busbar with required quantity of two-hole lugs for application. Provide as shown on the Drawings. Where not shown, provide one TMGB per primary telecommunications room (e.g. EF, ER, etc.).
Telecommunications Grounding Busbar (TGB): TGBs shall be a minimum of 2 inches wide and have a minimum length of 12 inches. Provide busbar with required quantity of two-hole lugs for application. Provide as shown on the Drawings. Where not shown, provide a minimum of one TGB per secondary communications room (e.g. TE, TR, ER, etc.).

2.3 BCT

Provide insulated green, insulated green with yellow strip, or un-insulated - copper conductor properly sized according to length of conductor and size of AC Grounding Electrode Conductor for the electrical service per NEC, TDMM, and IAEI calculations.

2.4 GE

Provide insulated green, insulated green with yellow strip, or un-insulated - copper conductor. Unless otherwise noted on the Drawings, conductors shall be sized according to conductor length as follows:

Less than 13 feet: #6 AWG
13 to 20 feet: #4 AWG
20 to 26 feet: #3 AWG
26 to 33 feet: #2 AWG
33 to 44 feet: #1 AWG
44 to 52 feet: #1/0 AWG
52 to 66 feet: #2/0 AWG
Greater than 66 feet: #3/0 AWG

2.5 TBB

Provide insulated green, insulated green with yellow strip, or un-insulated - copper conductor. Unless otherwise noted on the Drawings, conductors shall be sized according to conductor length as follows:

Less than 13 feet: #6 AWG
13 to 20 feet: #4 AWG
20 to 26 feet: #3 AWG
26 to 33 feet: #2 AWG
33 to 44 feet: #1 AWG
44 to 52 feet: #1/0 AWG
52 to 66 feet: #2/0 AWG
Greater than 66 feet: #3/0 AWG

2.6 TEBC

Provide insulated green or insulated green with yellow strip - 6 AWG copper conductor not to exceed 100 feet in length.

PART 3 - EXECUTION

3.1 GENERAL

Work shall comply with the Governing Requirements as defined in Division 27 Specification Section Basic Communications Requirements. Governing Requirements of particular relevance to this Section include, but are not limited to:

ANSI/NECA/BICSI 607: Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings
ANSI J-STD-607: Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
NEC: National Electric Code (NFPA Article 70)
UL 467: Grounding and Bonding Equipment

Contractor shall ensure that positive bonding connections are made to bare metallic surfaces, equipment, materials and hardware by removing surface corrosion, oxidation and paint prior to connection.

Where possible, bonds to structural steel shall be exothermic.

Where possible, exothermic or irreversible compression-type connections and two-hole lugs shall be used to terminate bonding conductors.

Labels/Identification: Label and identify all components of the communications grounding and bonding system.

3.2 GROUNDING BUSBARS:

Arrange telecommunication primary and secondary protector bonding, busbar bonding (e.g., BCT, GE, TBB, etc.) and approved building grounding conductors (e.g., toward the left, leaving space for equipment bonding conductors (e.g., TEBC, etc.) to the right.

TMGB:

Directly bond TMGB to:

Building structural steel (if building structural steel is approved building grounding system) via bonding conductor sized per BCT calculations – minimum size of 2/0 AWG copper conductor.
Intersystem Bonding Termination via BCT if BCT is less than 30 feet in length or if BCT length is shorter than bonding conductor length to nearest low-voltage electrical distribution panel.
Nearest low-voltage electrical distribution panel if Intersystem Bonding Termination is not available.
TGBs via TBBs as shown on drawings.

Label with “TMGB”.

TGB:

Directly bond TGB to:

Building structural steel (if building structural steel is approved building grounding system) via bonding conductor sized per BCT calculations – minimum size of 2/0 AWG copper conductor.
Nearest low-voltage electrical distribution panel
TMGB via TBBs as shown on drawings.
TGBs via TBBs as shown on drawings.
TGBs via GEs as shown on drawings.
Telecommunications equipment and materials via TEBCs.

Label with “TGB”.

3.3 GE

GEs shall be used to connect TGBs to other TGBs on designated floors. Route along the shortest and straightest path possible with minimal bends. Bends shall be sweeping. GEs shall be continuous (without splices), and shall be insulated from their support.

Label with “WARNING! TELECOMMUNICATIONS GROUNDING EQUALIZER (GE). DO NOT REMOVE OR DISCONNECT!” Labels shall be affixed at both ends and at accessible intermediate points.

3.4 TBB

TBBs shall be used to connect the TMGB to each TGB and TGB to TGB. Route along the shortest and straightest path possible with minimal bends. Bends shall be sweeping. TBBs shall be continuous (without splices), and shall be insulated from their support.

Label with “WARNING! TELECOMMUNICATIONS BONDING BACKBONE (TBB). DO NOT REMOVE OR DISCONNECT!” Labels shall be affixed at both ends and at accessible intermediate points.

3.5 TEBC

TEBCs shall be used to bond all non-current carrying metal telecommunications equipment and materials to the nearest TGB. Route along the shortest and straightest path possible with minimal bends. Bends shall be sweeping. TEBCs shall be continuous (without splices), and shall be insulated from their support.

Label with “WARNING! TELECOMMUNICATIONS EQUIPMENT BONDING CONDUCTOR (TEBC). DO NOT REMOVE OR DISCONNECT!” Labels shall be affixed at both ends and at accessible intermediate points.

3.6 QUALITY ASSURANCE AND TESTING

Visual inspection and correction of:

Loose connections
Corrosion
Physical damage
System modifications
Correct and visible labeling

Test Integrity of Bonding Connections

Perform two-point bonding measurements using an earth grounding resistance tester configured for continuity test per manufacturer's recommendations setup and safety precautions.

Measure between TMGB or TGB and nearest available grounding electrode (e.g., structural steel). Maximum value between two points shall be 0.1 ohm.
Measure between equipment, equipment racks, ladder racks, rack grounding busbars and TMGB or TGB. Maximum value between two points shall be 0.1 ohm.
Bonding resistance between any two conductive points in the EF, ER, TE, or TR shall not exceed 0.1 ohms.

Forward copy of test results to Engineer.

END OF SECTION 26 05 26

SECTION 27 05 33

ELECTRICAL TECHNOLOGY - CONDUIT AND BOXES

PART 1 - GENERAL

1.1 SUMMARY

This Section includes specific requirements for conduits and boxes within the Communications Pathway System as defined in Division 27 Specification Section *Basic Communications Requirements*. General requirements are covered in Division 27 Specification Section *Electrical Technology - General Requirements.*

1.2 RELATED SECTIONS

The requirements of Division 27 Specification Section *Electrical Technology - General Requirements* shall serve as the basis for the requirements of this Section, and are incorporated by reference into this Section.

Division 27 Specification Section *Electrical Technology – Underground Ducts and Raceways.*

1.3 SUBMITTALS

Comply with the Submittal portion of Division 27 Specification Section *Basic Communications Requirements*. Provide submittal information for the following:

Product Data

1.4 DEFINITIONS

EMT: Electrical Metallic Tubing

RMC: Rigid Metal Conduit

RNC: Rigid Nonmetallic Conduit

IMC: Intermediate Metal Conduit

Back Box: A pre-manufactured metallic or non-metallic box mounted within a floor, wall or ceiling and used to hold Communications Systems outlets/connectors, transition devices or equipment.

Device Boxes: Device boxes are Back Boxes that serve as a support point and/or an enclosure for various Communications Systems (Communications Cabling (Telecom) System and Security Systems) devices. Device boxes for Communications Systems devices other than Communications Cabling System devices typically have manufacturers' specific requirements that are identified elsewhere in the Construction Documents.

Outlet Box(es): Outlet box is another term used for Device Box.

PART 2 - MATERIALS

2.1 GENERAL

Part Numbers: Refer to the Equipment Schedule(s) on the Communications Construction Drawings for specific manufacturers and part numbers. If no part number is provided, then any part meeting the manufacturer and requirements specified is acceptable.

Refer to all of the Communications (Technology) System Details on the Communications Construction Drawings for additional requirements including, but not limited to Outlet Box size, Mud Ring gang size, conduit size and quantity and conduit routing. The Outlet Box size, Mud Ring gang size, conduit size and quantity and conduit routing requirements in the Details supersede the general Outlet Box size, Mud Ring gang size, conduit size and quantity and conduit routing requirements listed in this specification.

2.2 CONDUIT

Conduit types:

EMT shall be steel, hot-dipped galvanized or electro-galvanized, with an inner coating to protect cables and aid pulling, UL listed, and meeting the requirements of UL 797 and ANSI C80.3.
RMC shall be steel, hot-dipped galvanized inside and outside with factory threaded ends full cut and galvanized after threading, UL listed, and meeting the requirements of UL 6 and ANSI C80.1.
RNC shall be PVC Schedule 40 rigid plastic unless otherwise noted on the Drawings, shall be rated for use with 90 degree C wire, and shall conform to UL 651, WC-1094C and NEMA TC 2.
Flexible (flex) conduit: Flex conduit is not approved and not acceptable. Where, in rare instances, flex conduit is the only remaining viable raceway option, the Contractor shall notify the Engineer and await the Engineer's direction prior to procurement and installation.
Condulets (LB's): Condulets (LB's) are not approved and are not acceptable.

FITTINGS:

Provide fittings as follows:

EMT fittings shall be steel compression type with a nylon insulated throat for rain-tight and concrete-tight applications, steel set screw type or steel compression type for all other connections. Conduit ends shall be fitted with bushings – bushings shall be threaded type for RMC and IMC, set screw type for EMT, and have a nylon insulated throat.
RMC fittings shall be threaded galvanized steel. Conduit ends shall be fitted with bushings – bushings shall be threaded and have a nylon insulated throat.
RNC fittings shall be of same material and manufacturer as the conduit, shall be UL listed and conform to UL 514. Cement shall be as recommended by manufacturer.

Expansion fittings shall be provided across structural joints, shall be of a design to compensate for expansion and contraction, shall be sealed to prevent entrance of water and moisture, and shall safely deflect and expand up to twice the distance of the structural movement. Expansion fittings shall be approved for grounding duty.

2.3 JUNCTION BOXES

Junction boxes shall be provided to serve as a transition point between pathways/raceways. Junction boxes shall be galvanized stamped steel, deep drawn one piece (without welds or tab connections), with knockouts for conduit entrances, meeting NEMA OS 1.

Junction boxes shall not be used to support Communications System equipment.

Junction boxes shall not be placed in walls or non-accessible ceiling locations unless specifically shown on the Communications Construction Drawings or approved in writing by the engineer prior to rough-in and installation.

Junction boxes in locations other than walls shall be sized according to the NEC.

Junction boxes in walls:

Unless otherwise shown on the Drawings, junction boxes shall be minimum 4-11/16 inch by 4-11/16 inch by 2-1/8 inch deep with blank cover, and knockouts pre-manufactured to support the conduit size serving the junction box (i.e. field modifications of the junction boxes to support the conduit sizes specified are not acceptable).
Size according to the NEC and provide the larger of the minimum size mentioned above or the NEC requirements.

2.4 DEVICE BOXES

General: Unless otherwise shown on the Drawings or specified herein, device boxes shall:

Be galvanized stamped steel, deep drawn one piece (without welds or tab connections), with knockouts for conduit entrances, meeting NEMA OS 1, and equipped with extension rings to suit construction and application.
Have knockouts pre-manufactured to support the conduit size serving the outlet box (i.e. field modifications of the outlet box to support the conduit sizes specified are not acceptable).

Device Box Types:

Device Box: Typically installed as an empty box with blank faceplate, conduit and pull string for future use, unless specifically noted otherwise on the Communications Construction Drawings.

Shall be a minimum 4-11/16 inch by 4-11/16 inch by 2-1/8 inch deep capable of accepting a minimum of (2) 1 inch conduits.
Shall be equipped with a minimum single-gang mud ring unless otherwise noted on the Drawings.

Mud ring depth shall be sized according to the depth of the wall surface per the Architectural Construction Documents.

Provide a blank faceplate to match the material, style and color being used on the Electrical Wiring Devices.

Outlet Box: Outlet boxes shall be provided to house Communications System equipment/outlets/connectors. Unless otherwise noted in the Communications (Technology) System Details on the Communications Construction Drawings the typical Outlet Box(es) shall be as follows:

Communications Cabling System:

Shall be a minimum 4-11/16 inch by 4-11/16 inch by 2-1/8 inch deep capable of accepting a minimum of (2) 1 inch conduits
Shall be equipped with a single-gang mud ring unless otherwise noted on the Drawings or specified as follows:

Mud ring depth shall be sized according to the depth of the wall surface per the Architectural Construction Documents.
Wireless Access Point: Provide a cover plate in lieu of single-gang mud ring.

Security:

Refer to Communications (Technology) System Details on the Communications Construction Drawings and Manufacturers requirements. Coordinate with Security contractor prior to rough-in. Receive written directions as to device box requirements for each location.

2.5 PULL BOXES

Pull Boxes shall be code gauge sheet metal/fabricated steel continuously welded at seams and painted after fabrication. Boxes shall be complete with covers, trim, etc.

Minimum pull boxes sizes shall be as follows:

	PULL BOX SIZE			FOR EACH ADDITIONAL CONDUIT INCREASE
CONDUIT	WIDTH	LENGTH	DEPTH	WIDTH
1”	4”	16”	3”	2”
1-¼”	6”	20”	3”	3”
1-½”	8”	27”	4”	4”
2”	8”	36”	4”	5”
2-1/2"	10"	42"	5"	6"
3"	12"	48"	5"	6"
3-1/2"	12"	54"	6"	6"
4"	15"	60"	8"	8"

Pull Boxes for conduits sized larger than shown in the table above shall be provided as shown on the Drawings.

2.6 FLOOR BOXES

Floor boxes shall provide the space required for power, communication and/or audio/visual cabling and interface devices at floor level. For slab-on-grade floors, the floor box must be suitable for installation in “on-grade” conditions. Floor boxes shall be flush style, shall exceed UL scrub water exclusion requirements for tile and carpet floors, and shall be complete with covers, brackets and hardware to support installation as shown on Drawings.

Floor boxes may be combined for use by both power and communications where shown on the Drawings. When combined, provided metal dividers separating power from communications and provide separate conduits for power and communications.
Floor boxes shall be complete with brackets, cover plates, and/or other means to support power, communications, and/or audio-visual type connectors shown on the Drawings or called for in the Specifications.

Floor Box Types:

Single-Service Round Floor Box: Floor boxes shall be stamped steel, deep single-service. Covers shall accept a minimum of a 2-5/8” threaded opening.
Raised Floor Shallow Floor Box (2-gang): Floor boxes shall be shallow.
Shallow Floor Box (4-gang): Floor boxes shall be shallow.

Floor Box (4-gang): Floor boxes shall be in a recessed box, shall be adjustable before concrete pour, and shall be complete with brackets to support power, communications, and/or audio/visual type connectors as shown on the Drawings and specified in Specifications.
Deep Floor Box (6-gang): Floor boxes shall be in a recessed box, shall be adjustable before concrete pour, and shall be complete with brackets to support power, communications, and/or audio/visual type connectors as shown on the Drawings and specified in Specifications.
Floor Box (Flexible Conduit): Floor boxes shall be in a recessed box, shall be adjustable before concrete pour, and shall be complete with pans and brackets to support power, communications, and/or audio/visual type connectors as shown on the Drawings and specified in Specifications. Floor boxes shall be equipped with flexible conduit as required to interface into furniture. Floor boxes shall be approximately 7.5 inches x 7.38 inches by 3.5 inches deep, not including PVC riser. Pour pans shall be provided as required. Floor boxes shall be UL listed. Covers for floor boxes shall be included and shall support flexible conduit to furniture, as required. Covers shall be coordinated with Architect.

Floor Box Covers: Covers shall be provided for each floor box, shall support carpet/floor trim to match surrounding floor area, shall be UL listed to safety standards for tile, carpet and wood floor installation, and shall prevent water, dirt, and debris from entering power/communication/audio/visual outlets. Covers shall incorporate floor box manufacturer's protection to prevent water, dirt, and debris from entering the power and communication devices, and shall meet or exceed UL scrub water exclusion requirements for tile and carpet floors. Coordinate color with Architect and Owner. Cover type shall be:

Cast aluminum

2.7 POKE-THROUGHS

Poke through devices shall provide the interface for power, communication and/or audio/visual cabling in an above grade floor and the workstation location where power, communication and/or audio/visual outlets are required. Poke-through assembly shall be flush style, shall exceed UL scrub water exclusion requirements for tile and carpet floors, and shall be complete with brackets and hardware to support installation as shown on Drawings.

Poke-throughs may be combined for use by both power and communications where shown on the Drawings. When combined, provided metal dividers separating power from communications and provide separate conduits for power and communications.

2.8 OTHER BOX TYPES AND REQUIREMENTS

Provide as required according to the Equipment Schedules, Notes and Communications Details on the Communications Construction Drawings.

PART 3 - EXECUTION

3.1 CONDUIT

General:

Run conduit in the most direct route possible, parallel and perpendicular to building lines. Route conduits as close to structure as possible.
Do not route conduit through areas in which flammable material may be stored, or over or adjacent to boilers, incinerators, hot water lines, or steam lines.
Conceal all conduit unless indicated otherwise, within finished walls, ceilings, and floors.
Keep conduits at least 6-inches away from parallel runs of flues and steam or hot water pipes.

Install conduits level and square and at proper elevations.
For conduit runs exceeding more than 100 feet in length, provide pull boxes (see *Part 3 – Execution, Pull Boxes* herein) so that no conduit segment between end points/pull boxes exceeds 100 feet.
For conduit runs which require more than two 90 degree bends, install pull boxes (see *Part 3 – Execution, Pull Boxes* herein) so that no conduit segment between end points/pull boxes contains more than two 90 degree bends or a total of 180 degrees of bends including offsets and kicks.
Ream all conduits to eliminate sharp edges. Conduits shall be reamed after threads are cut.
Joints shall be cut square and shall butt solidly into couplings.
Terminate all metal conduits with metallic threaded insulated throat bushings, PVC conduit with PVC bushings.
Metallic conduits entering communication rooms shall be equipped with grounding lugs.
Prevent foreign matter from entering conduits by using temporary closure protection.
After cable installation, cap each unused conduit with a mechanical-type seal (tape is not acceptable).
Conduits shall be installed in such a manner as to keep exposed threads to an absolute minimum and in no case shall more than three threads be left exposed.
Install expansion fittings where conduit crosses an expansion join in structure or is in an environment where temperature changes combined with conduit run length may produce expansion or contraction stress. Provide a flexible bonding jumper at least three times the nominal width of the joint.
Terminate conduits that protrude through a floor 1 to 3 inches above the surface of the floor.
Conduits shall be cleaned and dried prior to the installation of cables.
Route conduit through roof openings for piping and ductwork wherever possible. Where not possible, provide and route through roof jack with pitch pocket for waterproofing.
Empty conduits passing through roof penetrations shall be capped and sealed weather tight.
Conduits passing through exterior walls and floors below grade shall be made watertight with duct plugs. Pipe sleeves and wall collars shall extend all around the conduit or entrance seals and be specifically manufactured for that purpose.
When using RNC, transition to RMC for all bends, stub-ups, and penetrations through foundation walls.

Conduit Schedule:

Buried or below grade level slab: RNC
Embedded in concrete slab: RNC
Through foundation walls: RMC
Corrosive/Hazardous Areas: RMC
Exposed or subject to mechanical injury: RMC
All other areas (unless otherwise noted): EMT

Minimum Conduit Sizing, where not shown on the Drawings,:

Junction Boxes in walls: 1 inch.
Device Boxes: 1 inch.
Pull Boxes: Provide per the Drawings.
Floor boxes: Provide per the Drawings. Where not shown, coordinate with the other Trades who will make use of the floor box and provide per their requirements. Conduits shall be provided per the manufacturer’s requirements and recommendations for the specified floor box.
Poke-throughs: The size of the conduit feeding the poke-through shall be the same size as the conduit stub of the poke-through.

Conduit bends:

A conduit bend shall not exceed 90 degrees and shall not be constructed in such a way as to reduce the effective diameter of the conduit.
Conduit bends (other than bends in OSP Conduit Ductbank) shall be sweeping, shall conform to TIA 569 bend radius requirements, and shall be a minimum of no less than 6 times the internal diameter of the conduit for conduits 2-inches or less and a minimum of no less than 10 times the internal diameter of the conduit for conduits greater than 2-inches.
For conduits larger than 1-1/4 inch, bends shall be factory-manufactured. Bending conduit larger than this in the field using manual or mechanical methods is not acceptable. 1 inch and 1-1/4 inch bends shall be made in an approved bending machine or shall be factory-manufactured.
The contractor shall test each conduit with a mandrel to prove compliance with TIA and cable manufacturer bend radius requirements throughout the conduit run and shall provide evidence of such testing immediately upon request of the Engineer.
The sum total of conduit bends for a conduit segment between end points/pull boxes shall not exceed 180 degrees, except one additional bend of up to 90 degrees is acceptable if the bend is located within 12 inches of the cable feed end.
90 degree condulets (LB's) are not acceptable.

Conduit Stubs:

From boxes in partition walls: Conduit stubs shall extend a minimum of 6-inches above top of partition wall and shall be angled 30 degrees toward the nearest raceway/pathway for horizontal cabling.
Through floor slabs: Arrange so curved portion of bend (if any) is not visible above finished slab.

Conduit/duct runs under slab: Coordinate with other trades (electrical, plumbing, etc.) prior to trenching and installation. Communications conduit/duct runs under slab shall not share a trench with conduit/duct runs from other trades.

Conduits embedded in slab: Not acceptable unless otherwise shown on the Drawings.

Pull String for horizontal and systems cable:

Equip all conduits over 3 feet long with plastic or nylon pull strings with printed footage indicators and a minimum test rating of 200 pounds. Extend pull string a minimum of 3 feet from each end. Pull strings shall be secured to avoid losing the pull string within the conduit by either securing tying the end of each string in place, or by tying the end of each string to a washer with a diameter larger than the conduit diameter.
Label each pull string in a clear manner by designating, at each end of the pull string, the location of the far end of the pull string (i.e. room name, communications closet name, pull box identifier, cable tray, station identifier, etc.). Indicate pull string length on the label.

Pull Ropes for backbone cable(Inside and Outside Plant):

Equip all conduits, over 3 feet long with 2400 pound test sequentially numbered pull tape, or equal. Where such conduits have innerducts, provide a 2400 pound test sequentially numbered pull tape (or equal) for each innerduct. Polyrope is not permitted. Pull rope shall be secured to avoid losing the pull rope within the conduit by either tying the end of each rope in place, or by tying the end of each rope to a washer with a diameter larger than the conduit diameter. Pull rope shall be exposed a minimum of 3 feet at the end of interior conduits and 10 feet at the end of exterior or underground conduits (ducts).

Label each pull rope in a clear manner by designating, at each end of the pull rope, the location of the far end of the pull rope (i.e. manhole name, communications closet name, pull box identifier, cable tray, etc.). Indicate pull rope length on the label.

Bushings: The Contractor is solely responsible for ensuring that bushings (insulated throat for metallic conduit, PVC for PVC conduit) are installed at conduit end(s) prior to cable installation. Where cable is installed prior to the installation of bushings, the Contractor shall remove the cable, install the bushing, and re-install the cable at no additional cost to the Owner.

Labels: Label each conduit end in a clear manner by designating, at each end of the conduit, the location of the far end of the conduit (i.e. room name, communications closet name, pull box identifier, cable tray, station identifier, etc.). Indicate conduit length on the label.

3.2 JUNCTION AND DEVICE BOXES

General:

Unless otherwise indicated, boxes shall be recessed. Set boxes plumb, level, square and flush with wall. Do not exceed more than 1/16 inch tolerance for each condition.
Recess outside edge and trim plates from finished surface in accordance with NEC.
Boxes shall be supported independently of the conduit system. Supports shall be noncombustible and corrosion resistant. Suspended boxes shall be supported with threaded rod hangers and galvanized steel clamps, or trapeze hangers such as Unistrut.
Box locations may be adjusted by the Engineer by up to 10 feet from the location shown on the Drawings at no additional cost to the Owner.
Install additional straps or cross-bracing to ensure a rigid installation in a steel stud system.
Boxes on opposite sides of fire rated walls and partitions shall be separated by a horizontal distance of at least 24 inches.
Unused knockouts in boxes shall be left sealed.
For acoustical purposes, boxes on opposite sides of a wall shall not be located back-to-back.
For boxes to be installed in brick, masonry or concrete, offsets shall be provided to provide for proper adjustment to finished surfaces. Exposed mortar is not acceptable around device plates.
In the event of discrepancies between box locations shown on the Communications drawings and any other drawings in the Construction Documents, the Contractor shall notify the Engineer and await the Engineer's direction prior to installation.

Device Box Types

Device Box:

Unless specifically noted otherwise on the Drawings, Device Boxes shall be dedicated to Communications Systems and shall not be shared with power. Provide with blank faceplate and pullstring.

Outlet Box:

General:

Unless specifically noted otherwise on the Drawings, Outlet Boxes shall be dedicated to Communications Systems, and shall not be shared with power. The contractor shall install the box and mudring such that the face of the mudring is flush with the face of the wall. Refer to the Architectural Construction Documents (Drawings and Specifications) for Wall Types, Materials and Installation Details.

The use of dividers to divide a single box into “separate” sections for Communications Systems and power (or another function) is not acceptable.

Communications Cabling System:

Outlet boxes shall be located within 3 feet of an electrical power receptacle. Where conditions are such that this is not possible, promptly notify the Engineer and await the Engineer’s direction prior to rough-in of the box.

Security System(s):

Refer to drawings and Manufacturers requirements.
Coordinate with Security contractor prior to rough-in.

3.3 PULL BOXES

Install pull boxes in an exposed location, readily accessible both at time of construction and after building occupation. Pull boxes shall not be installed in interstitial or otherwise non-accessible building spaces.

If mounting a pull box on ceiling structure above ceiling grid, do not mount higher than 4 feet above grid (mount on wall instead).

Install pull boxes such that conduit enters and exits only from opposite ends of the box (i.e. only two sides of a box may be used for conduit entry and those two sides must be opposite one another).

Do not install conduits into pullboxes in such a manner as to obstruct the installation of future feeder conduits into or out of the pullbox.

A pull box shall not be substituted for a 90 degree bend.

Do not exceed one pull box per total conduit run between outlet box and termination point in a communications closet, unless otherwise shown on the Drawings. Where field conditions necessitate the use of additional pull boxes notify the Engineer and await the Engineer's direction prior to procurement and installation.

Pull boxes shall be rigidly mounted. Unused knockouts shall be plugged with suitable blanking devices.

Labels: Label each pullbox with a unique identifier. Identifiers shall be of the form “RN-YY” where “RN” is the room name of the room closest to (or containing) the pull box, and “YY” is the sequential number of the pull box for each “RN”. For example: The second pull box in the vicinity of room “201” would have the label “201-02”.

3.4 FLOOR BOXES

Set boxes plumb, level, square and flush with floor. Do not exceed more than 1/16 inch tolerance for each condition.

Floor boxes shall have been tested for use in fire-resistance-rated assemblies applicable to the condition(s) present in Project, and shall be installed in accordance with the instructions included in the listing.

For floor boxes installed in concrete slab:

Coordinate floor boxes with slab/concrete topping depth. Where depth of floor box conflicts with slab depth notify the Engineer and await the Engineer's direction prior to procurement and installation.
Adjust box prior to and after concrete pour.

Covers shall be installed per manufacturer’s recommendations.

For floor boxes with combined power and communications circuits, install metal dividers for separation of circuits and provide separate conduits for power and communications.

3.5 POKE-THROUGHS

Poke-throughs shall be installed per manufacturer’s requirements and recommendations.

END OF SECTION 27 05 33

SECTION 27 05 43

ELECTRICAL TECHNOLOGY - UNDERGROUND DUCTS AND RACEWAYS

PART 1 - GENERAL

1.1 SUMMARY

This Section includes general requirements for the Underground Ducts and Raceways for the Communications System. General requirements are covered in Division 27 Specification Section *Electrical Technology – General Requirements*.

1.2 RELATED SECTIONS

The requirements of this Section are additional to, different from, or otherwise supplement the applicable requirements of Division 16. The applicable requirements of Division 16 shall serve as the basis for the requirements of this Section, and are incorporated by reference into this Section.

Division 27 Specification Section *Electrical Technology – Conduit and Boxes.*

1.3 REFERENCES

In addition to the Governing Requirements, the applicable portion of the following shall be incorporated by reference into this Section:

Concrete:

Reinforcement:

ACI 301: Structural Concrete for Buildings
ACI SP-66: American Concrete Institute - Detailing Manual
ANSI/ASTM A82: Cold Drawn Steel Wire for Concrete Reinforcement
ANSI/AWS D1.4: Structural Welding Code for Reinforcing Steel
ANSI/AWS D12.1: Reinforcing Steel Welding Code
ASTM A615: Deformed and Plain Billet Steel Bars for Concrete Reinforcement
AWS D12: Welding Reinforcement Steel, Metal Inserts and Connections in Reinforced Concrete Construction

Cast-in-Place:

ACI 212.3R: Chemical Admixtures for Concrete
ACI 301: Structural Concrete for Buildings
ACI 304: Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete
ACI 305R: Hot Weather Concreting
ACI 306R: Cold Weather Concreting
ASTM C33: Concrete Aggregates
ASTM C39: Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C94: Ready-Mixed Concrete
ASTM C150: Portland Cement
ASTM C143: Standard Test Method for Slump of Hydraulic Cement Concrete
ASTM C173: Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method

ASTM C231: Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C260: Air Entraining Admixtures for Concrete
ASTM C309: Standard Specifications for Liquid Membrane Forming Compound for Curing Concrete
ASTM C494: Chemical Admixtures for Concrete

Pre-Cast:

ASTM C478: Standard Specification for Precast Reinforced Concrete Manholes Sections
ASTM C857: Standard Practice for Minimum Structural Design Loading for Underground Precast Utility Structures
ASTM C858: Standard Specification for Underground Precast Concrete Utility Structures
ASTM C891: Standard Practice for Installation of Underground Precast Concrete Utility Structures
ASTM C1037: Standard Practice for Inspection of Underground Precast Concrete Utility Structures
ASTM D1751: Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)

Trenching and Backfill:

ASTM D1557: Test Method for Laboratory Compaction Characteristics Using Modified Effort

1.4 SUBMITTALS

Comply with the Submittal portion of Division 27 Specification Section *Basic Communications Requirements*. Provide submittal information for the following:

Product Data
Shop Drawings:

Raceway/pathway routing: Provide a raceway/pathway routing plan if such plan has not been shown on the Drawings, or if the Contractor is proposing a deviation from that shown.

If a routing plan is not required, submit written documentation stating that the routing will be provided as shown on the Drawings, that the Contractor has reviewed the routing shown on the Drawings with the other applicable trades and that all have agreed that it does not create conflicts between the trades, and the routing meets applicable codes, regulations and standards. If a routing plan is required, submit complete site plans or detail drawings showing the proposed routing and raceway sizes and locations in a manner equal to that of the Drawings. Ensure that any routing changes are coordinated with comparable changes to the communications cable routing. Specifically note each location where the proposed routing is different from the Drawings. Where deviations are proposed, submit written documentation detailing the reason for each. Each deviation must be approved in writing by the Engineer prior to proceeding with installation.

1.5 DEFINITIONS

Aggregate: The mineral materials such as sand or stone used in making concrete

Backfill: Earth material used specifically for filling and grading excavations back to a finished state. Backfill is placed on top of the bedding surrounding encased ductbanks and direct-buried conduits.

Base: Earth material used specifically to level and grade an excavation's subgrade for the subsequent placement of encased ductbanks, direct-buried conduit, and UCVs. Base material is placed on top of the subgrade and beneath the bedding surrounding encased ductbanks, conduits, or UCVs.

Bedding: Earth material used specifically for filling excavations. Bedding is placed around encased ductbank, conduits, or UCVs. Bedding is placed on top of the base and beneath the backfill.

Fill: The collective term for base, bedding, and backfill.

Handhole: A small UCV in which it is expected that a person cannot enter to perform work. Handholes are primarily used for the placement of cable, but are also occasionally used for splicing or for equipment.

Maintenance hole: A large UCV in which it is expected that a person can enter to perform work. Maintenance holes may be used for splicing and outside-rated telecommunications equipment.

Pullbox: A small UCV in which it is expected that a person cannot enter to perform work. Pullboxes are used for the placement of cable only; they are not used for splicing or for equipment.

Underground Cable Vault (UCV): Underground vaults (maintenance holes, handholes, or pullholes) which are used for the routing of communications cable.

Vault: See Underground Cable Vault (UCV).

PART 2 - MATERIALS

2.1 GENERAL

Materials shall consist of fill, topsoil, concrete formwork, concrete, raceway, UCVs, and other incidentals and accessories as required.

2.2 BASE, BEDDING AND BACKFILL

Use of onsite soils for base and bedding is not acceptable. Compacted onsite materials are acceptable for backfill.

Base: Base material shall have size and shape characteristics that will allow it to compact readily and shall conform to the following gradation requirements.

For Trenches (provide sand):

Sieve Size	Percent Passing
U.S. No. 10	35 - 100
U.S. No. 20	20 - 80
U.S. No. 40	10 – 55
U.S. No. 100	0 – 10
U.S. No. 200	0 - 3

Bedding: Same as Base - For Trenches, above.

Backfill:

For Trenches

Sieve Size	Percent Passing
½-inch Square	100
¼-inch Square	65 – 100
U.S. No. 10	40 – 100
U.S. No. 50	3 – 50
U.S. No. 100	0 – 4
U.S. No. 200	0 - 3

2.3 CAST-IN-PLACE CONCRETE

Formwork:

Forms: Forms shall be metal or plywood in good condition. Gypsum board may be used only for the formation of concrete encased ductbank. The Contractor will be allowed to use the most advantageous panel sizes and panel joint locations. Neat patches and minor surface imperfections will be permitted. Surfaces formed shall be true planes within ¼-inch in 10-feet.
Form Release Agent: Where metal or plywood forms are used the forms shall be coated with a form release agent prior to placement of concrete. Except for gypsum board, faces and edges of forms shall be coated with Burke Form Coating (or equal) applied at a rate of 500 to 550 square feet per unit. Gypsum board form material may be left in place for concrete encased ductbank after concrete placement and need not be coated with form release agent.
Curved Surfaces: Only curved forms shall be used for constructing curved structures and surfaces. If gypsum board is used for concrete encased ductbank, gypsum board may be used for curves provided that a minimum 15 foot bend radius is maintained.

Reinforcement:

Reinforcing Steel: Reinforcing Steel shall conform to ASTM A615, Grade 40. Steel shall be uncoated, free from rust, dirt, and loose scale.
Tie Wire: Tie wire shall be 18 gauge 40 or heavier black annealed wire.
Embedded Anchor Bolts: Embedded anchor bolts shall be mild galvanized steel, cold bent.

Concrete:

Cement: Different types of cement, including the same type of cement provided by more than one manufacturer, are not acceptable: Cement shall conform to:

ASTM C150-7, type 1.
Minimum compressive strength shall be 3,000 psi at 28 days per ASTM C39.
Maximum slump shall be 4 inches per ASTM C-143.

Aggregate: Aggregate shall conform to:

Course: ASTM C33-71 with a maximum size of 1-¼ inches.
Fine: ASTM C33-71.

Water: Water shall be fresh, clean, potable and not detrimental to concrete.
Admixtures:

Air Entrainment: Conform to ASTM C260 and ASTM C173 or C231 with 5 percent to 7 percent air entrainment.

Other: Other admixtures shall not be used without prior approval.

Curing Compound: Curing compound shall conform to ASTM C309 and shall be free from petroleum resins or waxes. Sealer-hardener formulated for sealing, surface hardening, and curing concrete shall be utilized. Curing method and rate of application shall be according to manufacturers recommendations.

2.4 DUCTS AND DUCTBANKS

Ducts: Provide in locations as shown on the drawings. Refer to Part - 3, Execution for details on when to use each type. All conduit, fittings, and adhesives shall be provided by the same manufacturer.

Types:

RNC – Rigid Non-Metallic Conduit (PVC):

Schedule 40 or 80:

RNC, unless otherwise noted, shall be NEMA TC 2 or TC 6 schedule 40 or 80 (see Part - 3, Execution for details on when to use each type) rigid polyvinyl chloride (PVC) approved for direct burial without concrete encasement. RNC shall be UL listed.
Fittings shall be NEMA TC 3 or TC 9, matched to conduit and material.

RGC – Rigid Galvanized Steel Conduit:

RGC shall be rigid steel conduit hot-dipped galvanized inside and out with threaded ends meeting ANSI C80.1.
Couplings: Unsplit, NPT threaded with galvanizing equal to and compatible with conduit. Running thread or set screw threaded fittings (except for three piece and watertight split couplings) are not acceptable.
Nipples: Factory made through eight-inches with no running threads.

PSC – PVC Coated Rigid Steel Conduit:

PSC shall be NEMA RN 1 rigid steel conduit coated with rigid polyvinyl chloride (PVC) on exterior.
Fittings shall be NEMA RN 1.

Fittings:

Bends/Sweeps:

Bends/sweeps shall be factory manufactured.
Bends shall consist of a single arc of not less than a 15 foot radius. Where this is not possible due to existing site conditions, a bend radius shall not be less than 10 times the internal diameter of the conduit.
Bends not less than 10 times the internal diameter of the conduit are acceptable at locations where duct/ductbank is stubbing vertically up into the floor of the building.
The use of 90 degree elbows, LB's, condulets, or the use of a UCV in place of a bend/sweep is not acceptable.

End Caps (Plugs): Provide pre-manufactured water-tight end caps for all ducts during construction. Tape is not an acceptable end cap or cover.

Duct plugs: Provide duct plugs for sealing around, organizing, and supporting innerducts and cables. Duct plugs shall provide a long-term airtight and watertight seal. Manufacturer shall be:

Jack Moon/Tyco (various sizes)

End Bells: Provide end bells for terminating conduit in UCVs. Do not provide for conduit ends terminating in UCVs which are equipped with TERM-A-DUCT.

Pull Ropes: Provide a 2400 pound strength sequentially numbered pull tape, or equal, in each duct and innerduct. Polyrope is not permitted.

Ductbanks:

Unless otherwise noted on the Drawings, ductbanks shall consist of concrete encased RNC (see CAST-IN-PLACE CONCRETE, above).
Duct Spacers/Supports: Provide high-density plastic interlocking spacers/supports to maintain uniformity of multiple ducts within a ductbank. Spacers shall be:

CARLON ELECTRICAL PRODUCTS: SNAP-LOC Series.

Warning Tape: Provide metallic warning tape above each ductbank. Tape shall be 6-inches wide and orange in color.
Grounding/Bonding: Provide a continuous (non-spliced) #2 bare ground along length of ductbank.
Refer to the Telecom Ductbank Details (TE-CEDB and/or TE-SEDB) in the Communications Systems Construction Drawings for additional material requirements.

2.5 LANDSCAPING

Topsoil: Topsoil shall be imported and used for all excavations in grass and landscaped areas.

PART 3 - EXECUTION

3.1 GENERAL

Work shall comply with the Governing Requirements as defined in Division 27 Specification Section *Basic Communications Requirements*.

Governing Requirements of particular relevance to this Section include, but are not limited to:

TIA - 758: Customer-owned Outside Plant Telecommunications Cabling Standard
TIA - 568: Commercial Building Telecommunications Cabling Standard
TIA - 569: Commercial Building Standard for Telecommunication Pathways and Spaces
TIA - 606: The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
TIA - 607: Commercial Building Grounding and Bonding Requirements for Telecommunications
BICSI: Customer Owned Outside Plant Design Manual
BICSI: Telecommunications Distribution Methods Manual
BICSI: BICSI Telecommunications Cabling Installation Manual

3.2 EXCAVATING, TRENCHING AND FILL

Excavation:

Excavations shall not be performed where the outside temperature is less than 35 degrees Fahrenheit or when there is standing water or snow on the subgrade.
Excavations requiring crossing of concrete or asphalt shall be performed only after the surface material has been saw cut and removed. Concrete shall be removed in complete sections from control joint to control joint regardless of the width of the excavation.
Concrete and asphalt shall be replaced to match existing depth, strength, color, and type of material.
Adjacent structures which may be compromised or damaged by excavation work shall be underpinned as evaluated and recommended by a registered structural engineer employed by the Contractor prior to proceeding with the work.
The Contractor shall maintain adequate separation between the excavation and adjacent underground utilities. The excavation shall be located such that ductbank and UCVs, when installed, shall have a minimum separation of three inches of well tamped dirt between concrete encased ductbanks and UCV and the nearest underground utility. This minimum separation shall increase to twelve inches for direct buried ductbanks. For gas lines a minimum separation of eighteen inches is required for concrete encased or direct buried ductbanks. For water a minimum separation of thirty-six inches is required for concrete encased or direct buried ductbanks.
Communications conduit/duct runs under slab shall not share a trench with conduit/duct runs from other trades.
Excavations shall not be left unprotected at the end of the work shift. Excavations shall be covered with steel sheets and barricaded prior to leaving the job site, in accordance with all applicable rules, regulations, building codes, and ordinances.
The Contractor shall not allow water to accumulate in excavations. The Contractor shall install, operate and maintain all pump or dewatering equipment necessary to meet this requirement.
Depth of excavation

For UCVs: Depth shall allow for the overall assembled height of the vault plus the added height of risers, covers and bedding material consisting of a minimum six to twelve inches of base. Width of excavation for UCVs shall provide for a minimum of six (6)-inches clearance around each side of the UCV.
For trenches: Depth shall be sufficient to cover a minimum of twenty-four inches (36 inches wherever possible) over the conduit or ductbank formation. Width of excavation for trenches shall be a minimum of six inches to each side of the ductbank formation. Depth of excavation for trenches shall allow for the proper alignment of ducts into UCVs.

Soft spots in the subgrade shall be over-excavated, filled, and compacted.
Excavation for trenching shall run true and as straight as practicable. Trenches shall be clear of stones and soft spots.
Trench grade shall be sloped to fall 3-inches per 100 feet in general and ¼ inch per foot where possible.

Slope shall fall toward lower UCVs or from high points toward both UCVs.
Slope shall always fall away from building entrances.

Fill:

Prior to the placement of fill, all groundwater and surface water shall be drained or pumped from the recipient area.
Frozen fill shall not be placed.

Base:

The subgrade bed to receive fill shall be scarified and moisture conditioned prior to placing materials.
Base material shall be moisture conditioned to within three percent of optimum moisture content and shall be placed in loose, horizontal layers.
The subgrade bed shall be leveled using sand for trenches and gravel for UCVs as necessary to form an even base.

Bedding:

For concrete encased ductbank:

Bedding lifts/layers shall not exceed 4-inches before compaction.

For Direct-buried Ductbank:

Lifts/layers shall not exceed 1 to 2 inches before compaction until the top of the ductbank is reached and shall not exceed 4 inches thereafter. Bedding shall be placed simultaneously on both sides of ductbank for the full width of the trench. The materials shall be carefully worked above, to each side, and below the ducts with a tool capable of preventing the formation of void spaces and without damaging the structure or waterproofing of the ducts.

Backfill:

Backfill lifts/layers shall not exceed 6 inches before compaction.

Compaction: Compaction shall be performed using a vibratory plate or roller or other mechanical device. Compaction through jetting or ponding is not acceptable. Compact per APWA Standard Specification Paragraph 7-10.3 (11).

Bedding: Material shall be compacted to a dense state equaling at least 95 percent of the maximum dry density per ASTM D1557.
Backfill: Material shall be compacted to within two (2)-feet of the finished surface with a minimum relative compaction of 90 percent of the maximum dry density per ASTM D1557. Material within two (2)-feet of the finished surface shall be compacted with a minimum relative compaction of 95 percent of the maximum dry density per ASTM D1557.

Waste Disposal: The Contractor shall remove all excavation materials and other construction debris from the site in a timely manner. Materials shall be disposed of legally.

3.3 CAST-IN-PLACE CONCRETE

Concrete shall be constructed in accordance with the applicable portions of the specifications, standards, codes and regulations (latest editions and amendments) listed in Section 1, References.

The Contractor shall submit a copy of the delivery receipt for each concrete delivery which shall include date, strength ordered, and location used.

Formwork:

Construction:

Forms: Forms shall be fabricated to provide minimum three inches of concrete between ducts and surrounding backfill. Forms shall be cleaned and free of debris prior to pouring concrete. Braces shall be unyielding and tight to prevent leakage. Maintain formwork construction tolerances complying with ACI 347. Formwork shall be readily removable without impact, shock, or damage to concrete surfaces and adjacent materials. Use chamfer strips fabricated to produce uniform smooth lines and tight edge joints for all exposed corners and edges. Note: chamfer strips are not required for concrete encased ductbank corners and edges.
Reinforcement: Reinforcement shall be constructed in accordance with ACI SP-6. Weld reinforcement in accordance with ANSI/AWS D1.4 or ANSI/AWS D12.1. Accurately position, support, and secure reinforcement against displacement. Support reinforcement by metal/plastic chairs, runners, bolsters, spacers, hangers, or other incidental materials as required.

Slope: For flatwork, forms shall be constructed with 1 percent side slope to both south and east sides.

Joints:

Control: Shall be built into form.
Expansion: Expansion joints shall be built into form, shall be premolded ½ inch thick, and shall conform to ASTM D1751. Top ½ inch of expansion joints shall be sealed with an approved joint sealer.

Removal: Remove forms after concrete has cured (see Curing below) for 7 days or after concrete has attained a compressive strength of 2000 psi. If gypsum board forms are used to form concrete encased ductbank they can be left in place and backfilled after the specified curing period.

Concrete:

Transport: Contractor shall comply with ACI 304. Concrete shall be transported from the mixer to the construction location via methods preventing separation of materials.
Application:

Prior to placement, inspect and complete formwork construction, reinforcement, and items to be embedded or cast-in.
Deposit concrete in forms in layers not deeper than 24 inches and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer on the preceding layer while the preceding layer is still plastic. Cold joints are not acceptable.
Concrete shall be deposited in a plastic condition and shall be uniformly worked around reinforcements.
Concrete shall be consolidate by internal machine vibration (stinger) during pouring.
Once concrete work has commenced, work shall be continuous until the work segment or section has been completed.
Cold Weather: Concrete shall be protected from damage caused by frost, freezing, or low temperatures in compliance with ACI 306R. When temperature is below 40 degrees F, water and aggregates shall be heated before mixing to obtain a concrete mixture of not less than 50 degrees F and not more than 80 degrees F.

Hot Weather: Concrete shall be protected from damage caused by hot weather in compliance with ACI 305R. When temperature is above 90 degrees F water shall be chilled before mixing to obtain a concrete mixture of not more than 90 degrees F. Cover reinforcing steel with water-soaked burlap if it becomes too hot immediately before placement of concrete. Temperature of steel shall not exceed the ambient air temperature.

Curing:

Concrete shall be protected from premature drying, rain, excessive temperatures, and mechanical injury during the curing period.
Concrete shall be cured for 7 days in accordance with ACI 301 and shall be kept continuously moist during this time. Concrete temperature shall be strictly maintained between 50 degrees and 90 degrees F during the curing period.
Provide curing and sealing compound to exposed slabs, sidewalks, curbs, etc. as soon as final finishing operations are complete (within 2 hours). Re-coat areas subjected to heavy rainfall within 3 hours of the initial application.

Finish:

Surfaces shall be consolidated, leveled and screened for evenness and uniformity. All excess concrete shall be removed. Low spots shall be filled. Surface shall be floated after water sheen has disappeared from surface.
Flatwork shall be finished with a special tool to match patterned finish of adjacent existing concrete.
Finish work shall be straight and even with tooled edges, control, and expansion joints.

Ductbanks:

Ductbanks shall have full length reinforcement with formed sides. Reinforcement shall be installed at each corner of the duct spacers/supports.
Concrete shall not be poured against trench walls. Concrete shall be consolidated during placement by an internal concrete vibrator.
Each UCV penetration shall be provided with reinforcing bars tied to UCV reinforcement. Each building penetration shall have reinforcement doweled into foundation wall at building entry.
Secure duct spacers/supports and reinforcing to prevent movement during concrete placement.

Protection for exposed concrete: Exposed concrete (i.e. sidewalk, driveway, etc.) shall be covered with plywood which is weighted with concrete blocks or similar heavy object in order to prevent surface damage.
Reinforcement bars shall be bonded and grounded to the nearest approved ground

3.4 DUCTS AND DUCTBANK

Ducts:

The type of duct to use shall be dictated by the application:

Outdoor underground – sand encased or direct buried: Provide RNC Schedule 80 or PSC.

Transition to PSC at stub up locations and at entrances to buildings.
Transition to PSC or RGC for short radius bends (i.e. bends with less than 15-foot radii sweeps).

Outdoor underground – concrete encased: Unless specified otherwise, provide RNC Schedule 40.

Transition to PSC at stub up locations and at entrances to buildings.

Exposed or within 5 feet of steam lines or Utilidor trenches: Provide RGC.

Fittings:

Duct ends shall be cut square and reamed to remove burrs and sharp ends. Duct shall extend the maximum distance into all fittings, couplings, and connectors. All fittings shall be tightened securely and sealed watertight (see below).
Bends/Sweeps:

Bends shall consist of a single arc of not less than a 15 foot radius. Where this is not possible, a bend radius shall not be less than 10 times the internal diameter of the conduit. Short radius bends (45 and 90 degrees) are not permissible.

Bends not less than 10 times the internal diameter of the conduit are acceptable at locations where duct/ductbank is stubbing vertically up into the floor of the building.

An individual bend shall not exceed 90 degrees.
A duct section may have no more than the equivalent of two 90 degree bends (a total of 180 degrees) between pull points. The 180 degree maximum shall include kicks and offsets. Where it is not possible to construct a section of duct within the 180 degree bend maximum, intermediary UCVs must be installed.
Two 90 degree bends separated by less than 10 feet is not permissible.
Bends for ducts within a common ductbank shall be parallel, measured from the same center-point.
Where factory manufactured bends cannot be obtained due to a unique bend radius, bends shall be formed only with factory recommended equipment and shall be manufactured in such a way as to ensure that the internal diameter of the duct is not changed.

End Caps (Plugs): End caps shall be placed on all duct ends throughout construction in order to prevent the intrusion of water or debris. End caps shall be installed on all duct that is not directly being worked on during the work day and on all ducts at night. End caps shall be left in place upon final completion of the work.
End Bells: For UCVs which are not equipped with TERM-A-DUCT, install protective end bells on ducts flush with UCV wall.

Sealing: Duct connections shall be made waterproof and rustproof by application of a watertight, conductive thread compound (for RGC and PSC) or by solvent-type cement (for RNC). Duct terminations in UCVs shall be sealed and grouted (to ensure that all voids in the joints are filled). Duct terminations in buildings shall be sealed/watertight until used for cable.
Test Mandrels:Each duct, once installed, shall be cleaned of debris with a wire brush or swab and shall be proven out with a minimum 16 inch long test mandrel which is ¼ inch smaller than the inside diameter of the duct. Test mandrel shall be pulled after backfilling but prior to the replacement of landscaping. The Contractor shall repair any duct that does not prove out at no cost to the Owner.

Duct shall be cleaned a minimum of two times in the same direction and swabbed with clean rags until the rag comes out of the conduit clean and dry. Swab away from buildings for duct sections connected to buildings.

Duct Entrances:

UCV's:

Duct entrances at opposite ends of a UCV shall be at the same level and in the same position with respect to the side walls. The Contractor shall ensure that each duct leaving a UCV in any position shall enter the next UCV in the same relative position.
UCVs shall not be drilled or penetrated without written Owner permission.

Buildings: Ducts shall terminate 4-inches above the finished floor.

Length: Unless otherwise shown on the Drawings, the maximum length of a duct run shall not exceed 500 feet between UCVs or pulling points. Install additional UCVs as required to maintain spacing.
Pull Ropes (pull tape, or equal): Install in each duct immediately after the duct has been cleaned and mandreled. Install a pull rope in each innerduct in lieu of the duct for such situations. Pull rope shall be without knots or splices. Leave a minimum of 10 feet looped and tied off at each end of the duct.
Protection: Insure that after installation all duct coatings and finishes are without damage.
Repair as follows:

PVC Coated Rigid Steel Conduit: Patch all nicks and scrapes in PVC coating after installing conduits.
Rigid Galvanized Steel Conduit: Repair damage to galvanized finishes with zinc-rich paint as recommended by the manufacturer.
Rigid Non-metallic Conduit: Repair damage with matching touchup coating recommended by the manufacturer.

Ductbanks:

Refer to the Telecom Ductbank Details (TE-CEDB and/or TE-SEDB) in the Communications Systems Construction Drawings for additional installation requirements.
Encased in Sand:

Warning Tape: Install metallic warning tape six inches below grade.
Grounding/Bonding: Install ground wire along length of ductbank. Bond to grounding electrodes of UCV's and to building service grounds.
Ductbank slope shall be such that ducts will drain away from building entrances (i.e. slope away from buildings).

Encased in Concrete:

See CAST-IN-PLACE CONCRETE, above.

Duct Spacers/Supports: Supports shall be spaced on eight (8) foot centers if encased in concrete and five foot centers otherwise. Spacers shall be interlocked horizontally only. Spacers encased in concrete shall be staggered at least six inches vertically.
Warning Tape: Install metallic warning tape six inches below grade.
Grounding/Bonding: Install ground wire along length of ductbank. Bond to grounding electrodes of UCV's and to building service grounds.
Ductbank slope shall be such that ducts will drain away from building entrances (i.e. slope away from buildings).

3.5 LANDSCAPING

The Owner will seed and maintain grass areas disturbed by construction activity. Shrubbery damaged, removed or disturbed by construction activity will be replaced by the Owner.

Topsoil: Provide loosely compacted topsoil to a depth of 4 inches or depth of excavation for excavations less than 12 inches. Place imported topsoil for all excavations in turfed or landscaped areas. Restore existing grades where disturbed. Topsoil, once properly placed, shall be raked and smoothed. Installation shall be acceptable for landscaping by Owner. Place topsoil per APWA Paragraph 8-01.3(2).

END OF SECTION 27 05 43

SECTION 27 05 45

ELECTRICAL TECHNOLOGY - MAINTENANCE AND HAND HOLES

PART 1 - GENERAL

1.1 SUMMARY

This Section includes general requirements for the Maintenance and Hand Holes (Underground Cable Vaults) for the Communications System. General requirements are covered in Division 27 Specification Section *Electrical Technology – General Requirements*.

1.2 RELATED SECTIONS

The requirements of this Section are additional to, different from, or otherwise supplement the applicable requirements of Division 26. The applicable requirements of Division 26 shall serve as the basis for the requirements of this Section, and are incorporated by reference into this Section.

The requirements of this Section are additional to, different from, or otherwise supplement the applicable requirements of Specification Section *Electrical Technology – Underground Ducts and Raceways*. The applicable requirements of Specification Section *Electrical Technology – Underground Ducts and Raceways* shall serve as the basis for the requirements of this Section, and are incorporated by reference into this Section.

1.3 REFERENCES

In addition to the Governing Requirements, the applicable portion of the following shall be incorporated by reference into this Section:

Concrete:

Pre-Cast:

ASTM C857: Standard Practice for Minimum Structural Design Loading for Underground Precast Utility Structures
ASTM C858: Standard Specification for Underground Precast Concrete Utility Structures
ASTM C891: Standard Practice for Installation of Underground Precast Concrete Utility Structures
ASTM C1037: Standard Practice for Inspection of Underground Precast Concrete Utility Structures
ASTM D1751: Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)

Trenching and Backfill:

ASTM D1557: Test Method for Laboratory Compaction Characteristics Using Modified Effort

1.4 SUBMITTALS

Comply with the Submittal portion of Division 27 Specification Section *Basic Communications Requirements*. Provide submittal information for the following:

Product Data
Shop Drawings:

UCV location: Provide a UCV location plan if such plan has not been shown on the Drawings, or if the Contractor is proposing a deviation from that shown.

1.5 DEFINITIONS

Aggregate: The mineral materials such as sand or stone used in making concrete

Backfill: Earth material used specifically for filling and grading excavations back to a finished state. Backfill is placed on top of the bedding surrounding encased ductbanks and direct-buried conduits.

Base: Earth material used specifically to level and grade an excavation's subgrade for the subsequent placement of encased ductbanks, direct-buried conduit, and UCVs. Base material is placed on top of the subgrade and beneath the bedding surrounding encased ductbanks, conduits, or UCVs.

Bedding: Earth material used specifically for filling excavations. Bedding is placed around encased ductbank, conduits, or UCVs. Bedding is placed on top of the base and beneath the backfill.

Fill: The collective term for base, bedding, and backfill.

Handhole: A small UCV in which it is expected that a person cannot enter to perform work. Handholes are primarily used for the placement of cable, but are also occasionally used for splicing or for equipment.

Maintenance hole: A large UCV in which it is expected that a person can enter to perform work. Maintenance holes may be used for splicing and outside-rated telecommunications equipment.

Pullbox: A small UCV in which it is expected that a person cannot enter to perform work. Pullboxes are used for the placement of cable only; they are not used for splicing or for equipment.

Underground Cable Vault (UCV): Underground vaults (maintenance holes, handholes, or pullbox(es) which are used for the routing of communications cable.

Vault: See Underground Cable Vault (UCV).

PART 2 - MATERIALS

2.1 GENERAL

Part Numbers: Refer to the Equipment Schedule(s) on the Communications Construction Drawings for specific manufacturers and part numbers. If no part number is provided, then any part meeting the manufacturer and requirements specified is acceptable.

Other materials shall consist of fill, topsoil, UCVs, and other incidentals and accessories as required.

2.2 BASE, BEDDING AND BACKFILL

Use of on-site soils for base, bedding, and backfill is not acceptable.

Base: Base material shall have size and shape characteristics that will allow it to compact readily and shall conform to the following gradation requirements.

For UCVs (provide gravel):

Sieve Size	Percent Passing
1 inch Square	100
¼ inch Square	25 – 80
U.S. No. 200	15.0 max
Sand Equivalent	30 min

Backfill:

For UCVs - Same as Base - For UCVs, above.

2.3 UNDERGROUND CABLE VAULTS (UCVS)

Manufacturer: UCVs shall be precast in an established precast yard. Precast components shall conform to the requirements of ASTM C858 and other ASTM standards and specifications as listed in References, above. Precast UCVs shall be free from damaged joint surfaces, cracks, or other damage that would permit infiltration. Precast concrete structures may be repaired; repairs shall be performed only by the manufacturer in such a manner as to ensure that the repaired structure conforms to the requirements of this Specification and ASSTM C858. UCVs and incidental and miscellaneous equipment (such as cable racking brackets and supports) shall be supplied by a single manufacturer and shall be manufactured by:

Oldcastle Precast (no substitutions)

Formerly Amcor Precast

UCVs:

Handholes: Handholes shall be provided in the locations and sizes shown on the Drawings.

Sizes and Types:

3’-1” W by 6’-7” L by 4’-0” H (exterior dimensions). Handhole shall be complete with galvanized hatch (see below), Base Section, section gaskets, and two galvanized pulling iron per longitudinal side (four total). Handhole shall be provided with one galvanized “C” channel per longitudinal side.

Covers and Frames: Covers shall be rectangular, equipped with a self latching galvanized cover with steel tread plate and galvanized steel slam lock, recessed lift inserts, lock down bolts, shall be embossed in the lid casting with minimum 2 inch high letters stating “COMMUNICATIONS”, shall be of and shall conform to AASHTO HS-20 loading (incidental traffic). Frames shall be galvanized and adjustable.

Racking and Hardware: Provide two cable racks per longitudinal side (four racks total) per handhole. Provide four 7-½ inch cable support arms per handhole. Provide all incidental hardware for mounting racks and cable support arms.

Pullbox: Pullboxes shall be provided in the locations and sizes shown on the Drawings.

Size and Type:

2'-3" W by 5'-2½" L by 2'6" H (exterior dimensions). Pullbox shall be complete with Cover Section, Base Section, section gaskets, and one galvanized pulling iron per longitudinal side (two total).

Covers and Frames:

Covers shall be of the same nominal length and width as the pullbox, shall be equipped with self latching galvanized steel slam locks, recessed lift inserts, lock down bolts, shall be embossed in the lid casting with minimum 2 inch high letters stating "COMMUNICATIONS", and shall conform to AASHTO HS-20 loading (incidental traffic).

Racking and Hardware: Provide one cable rack per longitudinal side (two racks total) per pullbox. Provide two 7-½" cable support arms per pullbox. Provide all incidental hardware for mounting racks and cable support arms.

Grounding: UCVs (with the exception of small pullboxes) shall be complete with a minimum of one ¾ inch by 10 foot copperclad steel ground rods, and one #6 (minimum) pigtail for connection to interior ground conductors.

2.4 LANDSCAPING

Topsoil: Topsoil shall be imported and used for all excavations in grass and landscaped areas.

PART 3 - EXECUTION

3.1 GENERAL

Work shall comply with the Governing Requirements as defined in Division 27 Specification Section *Basic Communications Requirements*.

Governing Requirements of particular relevance to this Section include, but are not limited to:

TIA - 758: Customer-owned Outside Plant Telecommunications Cabling Standard
TIA - 568: Commercial Building Telecommunications Cabling Standard
TIA - 569: Commercial Building Standard for Telecommunication Pathways and Spaces
TIA - 606: The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
TIA - 607: Commercial Building Grounding and Bonding Requirements for Telecommunications
BICSI: Customer Owned Outside Plant Design Manual
BICSI: Telecommunications Distribution Methods Manual
BICSI: BICSI Telecommunications Cabling Installation Manual

3.2 EXCAVATING, TRENCHING AND FILL

Excavation:

Excavations shall not be performed where the outside temperature is less than 35 degrees Fahrenheit or when there is standing water or snow on the subgrade.

Excavations requiring crossing of concrete or asphalt shall be performed only after the surface material has been saw cut and removed. Concrete shall be removed in complete sections from control joint to control joint regardless of the width of the excavation. Concrete and asphalt shall be replaced to match existing depth, strength, color, and type of material.
Adjacent structures which may be compromised or damaged by excavation work shall be underpinned as evaluated and recommended by a registered structural engineer employed by the contractor prior to proceeding with the work.
The Contractor shall maintain adequate separation between the excavation and adjacent underground utilities. The excavation shall be located such that ductbank and UCVs, when installed, shall have a minimum separation of three inches of well tamped dirt between concrete encased ductbanks and UCV and the nearest underground utility. This minimum separation shall increase to twelve inches for direct buried ductbanks. For gas lines a minimum separation of eighteen inches is required for concrete encased or direct buried ductbanks. For water a minimum separation of thirty-six inches is required for concrete encased or direct buried ductbanks.
Communications conduit/duct runs under slab shall not share a trench with conduit/duct runs from other trades.
Excavations shall not be left unprotected at the end of the work shift. Excavations shall be covered with steel sheets and barricaded prior to leaving the job site, in accordance with all applicable rules, regulations, building codes, and ordinances.
The Contractor shall not allow water to accumulate in excavations. The Contractor shall install, operate and maintain all pump or dewatering equipment necessary to meet this requirement.
Depth of excavation

For UCVs: Depth shall allow for the overall assembled height of the vault plus the added height of risers, covers and bedding material consisting of a minimum six to twelve inches of base. Width of excavation for UCVs shall provide for a minimum of six inches clearance around each side of the UCV.
For trenches: Depth shall be sufficient to cover a minimum of 24 inches (36 inches wherever possible) over the conduit or ductbank formation. Width of excavation for trenches shall be a minimum of six inches to each side of the ductbank formation. Depth of excavation for trenches shall allow for the proper alignment of ducts into UCVs.

Soft spots in the subgrade shall be over-excavated, filled, and compacted.
Excavation for trenching shall run true and as straight as practicable. Trenches shall be clear of stones and soft spots.
Trench grade shall be sloped to fall 3 inches per 100-feet in general and ¼ inch per foot where possible.

Slope shall fall toward lower UCVs or from high points toward both UCVs.
Slope shall always fall away from building entrances.

Fill:

Prior to the placement of fill, all groundwater and surface water shall be drained or pumped from the recipient area.
Frozen fill shall not be placed.
Base:

The subgrade bed to receive fill shall be scarified and moisture conditioned prior to placing materials.
Base material shall be moisture conditioned to within three percent of optimum moisture content and shall be placed in loose, horizontal layers.

The subgrade bed shall be leveled using sand for trenches and gravel for UCVs as necessary to form an even base.

Backfill:

Backfill lifts/layers shall not exceed 6 inches before compaction.

Compaction: Compaction shall be performed using a vibratory plate or roller or other mechanical device. Compaction through jetting or ponding is not acceptable. Compact per APWA Standard Specification Paragraph 7-10.3 (11).

Bedding: Material shall be compacted to a dense state equaling at least 95 percent of the maximum dry density per ASTM D1557.
Backfill: Material shall be compacted to within 2 feet of the finished surface with a minimum relative compaction of 90 percent of the maximum dry density per ASTM D1557. Material within 2 feet of the finished surface shall be compacted with a minimum relative compaction of 95 percent of the maximum dry density per ASTM D1557.
Waste Disposal: The Contractor shall remove all excavation materials and other construction debris from the site in a timely manner. Materials shall be disposed of legally.

3.3 UNDERGROUND CABLE VAULTS (UCVS)

UCVs shall be installed strictly according to the manufacturer's recommendations.

Setting and Placement: Excavations shall be free of water and shall have bedding material properly installed prior to setting the UCV. Section seal surfaces must be clean and free from dirt or other material.

UCVs shall be set in place by lowering each section of the UCV into the excavation, ensuring that the UCV section is set level, plumb, and firmly positioned, and ensuring that the section gasket/seal is properly installed and watertight prior to setting the next section.
The UCVs shall be carefully set in order to ensure that the maintenance hole rim/lid elevation shall be:

Flush: For existing concrete or asphalt in paved and improved areas
2 inches above grade: For landscaped or unimproved areas

Knockouts: Knockouts shall be removed by striking the knockout with a single moderately heavy blow with a hammer or similar tool.

Duct Entrances: Duct entrances at opposite ends of a UCV shall be at the same level and in the same position with respect to the side walls. The Contractor shall ensure that each duct leaving a UCV in any position shall enter the next UCV in the same relative position.

Grouting: Grout shall be applied in a manner to insure filling of all voids in the joints being sealed. Grouting shall be applied to conduit entrances, risers, and covers in addition to any other voids.

Racking and Hardware: Install racking and hardware and incidental materials.

Grounding/Bonding: Bond all metallic hardware in the vault to the pre-cast bonding tabs. Bond the bonding tabs to the ground rod.

Cleaning: The UCV shall be completely cleaned and dried after all construction activity is complete and prior to releasing the UCV to the Owner for the Owner's use.

3.4 LANDSCAPING

The Owner will seed and maintain grass areas disturbed by construction activity. Shrubbery damaged, removed or disturbed by construction activity will be replaced by the Owner.

Topsoil: Provide loosely compacted topsoil to a depth of 4 inches or depth of excavation for excavations less than 12 inches. Place imported topsoil for all excavations in turfed or landscaped areas. Restore existing grades where disturbed. Topsoil, once properly placed, shall be raked and smoothed. Installation shall be acceptable for landscaping by Owner. Place topsoil per APWA Paragraph 8-01.3(2).

END OF SECTION 27 05 45

SECTION 27 10 00

COMMUNICATIONS - GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

This Section includes general cabling requirements for the Communications Cabling System.

1.2 RELATED SECTIONS

Division 27 Specification Section *Common Work - Sleeves, Penetrations and Firestopping.* Provide sleeves, penetrations, and firestopping as required to support the work of this Section.

Division 27 Specification Section *Common Work – Hangers and Supports.* Provide hangers and supports as required to support the work of this Section.

Division 28 Specification Section *Security – General Requirements.* Review the specifications to determine if there is any cabling scope of work related to the cabling described in the specification below.

1.3 SUBMITTALS

Provide the following per the criteria set forth in Submittals in Division 27 Specification Section *Basic Communications Requirements*:

Product Data
Shop Drawings:

Cable Routing: Provide a cable routing plan if communications cable routing has not been shown on the Drawings, or if the Contractor is proposing a deviation from that shown.

If a routing plan is not required, submit written documentation stating that the routing will be provided as shown on the Drawings, that the Contractor has reviewed the routing shown on the Drawings with the other applicable trades and that all have agreed that it does not create conflicts between the trades, and the routing meets applicable codes, regulations and standards. If a routing plan is required, submit complete floor plans or detail drawings showing the proposed routing, raceway sizes and locations, and cabling in a manner equal to that of the Drawings. Ensure that any routing changes are coordinated with comparable changes to the raceway routing. Specifically note each location where the proposed routing is different from the Drawings. Where deviations are proposed, submit written documentation detailing the reason for each. Each deviation must be approved in writing by the Engineer prior to proceeding with installation.

Termination Block Wall Field Terminations and Elevations: Provide termination block wall field termination diagrams and elevation drawings where such diagrams and elevations have not been shown on the Drawings, or if the Contractor is proposing a deviation from that shown.

Where changes to the wall field termination diagrams and elevation drawings are proposed, submit wall field termination diagrams and elevation drawings in a manner equal to that of the Drawings. Specifically note areas where deviations are proposed, and submit written documentation detailing the reason for each. Each deviation must be approved in writing by the Engineer prior to proceeding with installation.

Other:

Owner Specific: Submit other information as required by Owner Specific Governing Requirements in Specification Section *Basic Communications Requirements*..

PART 2 - MATERIALS

2.1 GENERAL

Manufacturer: Structured cabling system components shall be sourced by a single Manufacturer or formally partnered Manufacturers (collectively referred to as the "Manufacturer"). Products shall not be intermixed between different manufacturers unless the Manufacturer of the chosen communications cabling system has listed (in writing) another manufacturer's component as an "approved alternative product" (or equivalent wording) and will warrant the "approved alternative product" as part of the Manufacturer's extended Warranty, or if the product has been specifically called out as a special requirement in the Specifications. Additionally, for a given Manufacturer, all products shall be part of a single product line and the product line shall be specifically engineered "end-to-end" (e.g. the system and all of its components shall have been engineered to function together as a single, continuous transmission path). The structured cabling system shall be:

CommScope – Uniprise
Corning (only where specifically listed)

Plenum Rating:

Cable shall be plenum (CMP, OFNP) rated unless otherwise indicated. Cable shall bear plenum markings.

Color: All cables of the same type (i.e. Copper Backbone, Copper Horizontal, Fiber Horizontal, Coaxial CATV Trunk, 62.5µm MM, 50µm MM, SM, etc.) shall be of the same color. Multiple colors of the same cable type are not acceptable.

Part Numbers: Refer to the Equipment Schedule(s) on the Communications Construction Drawings for specific manufacturers and part numbers. If no part number is provided, then any part meeting the manufacturer and requirements specified is acceptable.

2.2 PERFORMANCE

Protocols/Services:

At a minimum, the communications cabling system shall support data network protocols/services at rates up to 10 Gbps for transmission on copper and 10 Gbps for transmission on fiber. It shall support Ethernet, ATM and other network protocols. The communications cabling system shall additionally support RS-232 and other dedicated point-to-point protocols.
The communications cabling system shall support PBX telephone services. It shall support analog, digital, and ISDN services, and shall be compatible with direct trunk lines (POTS).

Category Rating: Copper components (cable, connectors, etc.) shall meet or exceed the TIA transmission requirements for the Category for which they are rated.

Horizontal Cable shall be rated Category 6A (Standards Compliant).
Backbone Cable shall be rated Category 3 or higher.

Performance Rating: All components (copper and fiber) shall meet or exceed TIA transmission requirements for their component type.

Fiber Performance:

Backbone Cable:

62.5/125 µm Multimode (OM1): Provide extended/high grade cable with a maximum attenuation of 3.5 dB/km at 850 nm and 1.0 dB/km at 1300 nm. The minimum cable bandwidth shall be 200 MHz-km 850 nm and 500 MHz-km at 1300 nm. Color shall be orange.

PART 3 - EXECUTION

3.1 GENERAL

Work shall comply with the Governing Requirements as defined in Division 27 Specification Section *Basic Communications Requirements*. Governing Requirements of particular relevance to this Section include, but are not limited to:

TIA - 568: Commercial Building Telecommunications Cabling Standard
TIA 569: Commercial Building Standard for Telecommunication Pathways and Spaces
ANSI 310-D: Cabinets, Racks, Panels and Associated Equipment
TIA 606: The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
ANSI/NECA/BICSI 607: Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings
ANSI J-STD-607: Commercial Building Grounding and Bonding Requirements for Telecommunications
TIA - 758: Customer-owned Outside Plant Telecommunications Cabling Standard
ANSI/TIA 942: Telecommunications Infrastructure Standard for Data Centers
IEEE 802.3 (series): Local Area Network Ethernet Standards
BICSI: Customer Owned Outside Plant Design Manual
BICSI: Information Transport Systems Installation Manual
BICSI: Telecommunications Distribution Methods Manual
BICSI: Telecommunications Cabling Installation Manual
BICSI: Wireless Design Manual
National Electric Code (NFPA 70)

Owner required Governing Requirements of particular relevance to this Section include, but are not limited to:

3.2 GENERAL INSTALLATION

Maintain separation from other conductors (power, fire alarm, etc.) per NEC requirements and TIA standards.

The bending radius and pull strength requirements of all cable as detailed in the Governing Requirements and Manufacturers recommendations shall be strictly observed during handling and installation.

Pull cables simultaneously where more than one cable is being installed in the same raceway.

Use pulling compound or lubricant where necessary. Use compounds that will not damage conductor or insulation.

Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cable or raceway.

Cable jackets shall not be twisted during installation. Cables showing evidence of twisting shall be replaced at no additional cost to the Owner, regardless of the outcome of cable testing.

Cable shall be installed in a continuous (non-spliced) manner unless otherwise indicated on the Drawings. Where splicing may be required in areas not shown on the Drawings due to Cable Spool length limitations or otherwise, the Contractor shall obtain the approval of the Engineer prior to procurement and installation.

Provide strain relief to ensure durable connections at all cable termination locations.

Pathway/Raceway Validation: The Contractor is responsible for validating pathway/raceway sizing against the amount of cable it is to support for compliance with NEC and TIA 569 cable capacity standards. The Contractor shall notify the Engineer of all raceways the Contractor determines to be insufficient in size and shall await the Engineer's direction prior to procurement and installation.

Copper Cables:

Backbone Cable: All pairs shall be terminated. Unless otherwise noted on the Drawings, the installation of un-terminated cable pairs is not acceptable. For shielded cable, bond both ends of the metallic shield (or metallic strength member) to the nearest TGB.
Horizontal Cable: Thoroughly clean and remove foreign material from outlet boxes prior to installation of cable.

Fiber Cables:

Cables shall be tested on reel prior to installation. Cable which does not pass shall not be installed and shall be replaced at no additional cost to the Owner. "Repairing" cables which do not pass is not acceptable.
All fiber strands shall be terminated. Unless otherwise noted on the Drawings, the installation of unterminated (i.e. "dark fiber") is not acceptable.
Fiber splices shall be fusion. Mechanical splices are not acceptable. Each fusion splice shall be protected in a splice tray or similar protective device that is designed to mount within the enclosure. Bare/stripped optical fiber strands shall be protected with a buffer tube, heat shrink or silicon adhesive to prevent exposure to moisture.

Provide Sleeves and Penetrations as necessary where cable must pass through building barriers such as walls, floors or foundations. Firestop all through and membrane penetrations of fire-rated barriers. Sleeves, Penetrations and Firestopping shall be per the requirements of Division 27 Specification Section *Common Work - Sleeves Penetrations and Firestopping.*

3.3 CABLE INSTALLED IN RACEWAY

In Conduit or Ducts:

Fill ratios shall not exceed NEC requirements.

Cable shall not be pulled into conduit/ducts until the conduit/duct ends have been prepared for cable installation (i.e. ducts cleaned and swabbed, reamed to eliminate sharp edges, bushings installed (insulated throat for metallic conduits, PVC for PVC conduits), etc.). Cables pulled into conduit/ducts prior to conduit/duct end preparation shall be removed and replaced (after the conduit/duct ends are prepared) at no additional cost to the Owner.
Backbone (riser) cables shall not share conduits/ducts with horizontal cables.
Reinstate pull-wires in conduits and ducts after use to facilitate future addition of cables.

3.4 CABLE NOT INSTALLED IN RACEWAY (E.G. “EXPOSED”):

Cables shall be strapped, fastened or tie-wrapped for support. Staples are not acceptable.

Straps, fasteners, and tie-wraps shall not be over-tightened. Cables showing evidence of over-tightening shall be replaced at no additional cost to the Owner, regardless of the outcome of cable testing.
Straps, fasteners, and tie-wraps shall be plenum or non-plenum rated to match that of associated cable.
Cables shall be loosely grouped by application (horizontal or backbone) and by cable type (Cat 3, Cat 5E, Cat 5, Cat 6, MM Fiber, SM Fiber, etc.). Cable applications and types shall not be intermixed within a grouping.

Cables in suspended cable runs shall be supported at varying intervals. Cable spans shall be limited to 5 feet or less, and the length of spans shall vary along the cable path (i.e. a given span should not be exactly the same length as the span preceding or following it – “exact” spans can degrade cable performance).

Cable installed on exposed surfaces or structural members shall be installed parallel and perpendicular to the surfaces. Surface contours shall be followed wherever possible. Cables shall be attached to surfaces at intervals not to exceed 3 feet, and the length of spans shall vary along the cable path (i.e. a given span should not be exactly the same length as the span preceding or following it – “exact” spans can degrade cable performance).

Attaching cables to pipes, electrical conduit, mechanical items, existing cables, or the ceiling support system (grids, hanger wires, etc. – with the exception of ceiling support anchors) is not acceptable.

Cables exiting floor or wall penetrations and running exposed into furniture or casework shall be bundled and wrapped in spiral wrap or split-loom tubing for protection.

The quantity of cables installed in j-hooks, straps, and other similar fasteners shall not exceed manufacturer maximum loads for the fastener. Provide additional fasteners as required to meet load and future capacity requirements.

Route cable to comply with the Governing Requirements standards and rules for avoiding potential EMI sources of interference and as follows:

Provide clearances of:

18 inches from light fixtures
12 inches from electrical power distribution (including conduits and cables)
4 feet from motors and transformers

Cable pathway shall cross perpendicular to potential EMI sources of interference.

3.5 CABLE IN COMMUNICATIONS ROOMS AND SPACES

Cable on backboards:

Lay and dress all cables to allow other cables to enter raceway (conduit or otherwise) without difficulty at a later time by maintaining a working distance from these openings. Cable shall be routed as close as possible to the ceiling, floor, sides, or corners to insure that adequate wall or backboard space is available for current and future equipment and for cable terminations.
Lay cables via the shortest route directly to the nearest edge of the backboard from mounted equipment or blocks. Secure all similarly routed and similar cables together and attach to D-rings vertically or horizontally, then route over a path that will offer minimum obstruction to future installations of equipment, backboards or other cables.

Cable Bundles:

Cables shall be bundled by application (horizontal or backbone) and by cable type (Cat 3, Cat 5E, Cat 5, Cat 6, MM Fiber, SM Fiber, etc.). Cable applications and types shall not be intermixed within a bundle.
Cable bundles shall be combed to present a neat and professional appearance. For performance reasons, combing shall occur from the cable end to a maximum of 20 feet back (or per the Manufacturer's recommendations, whichever is more stringent). For the portion of a cable bundle within the communications room exceeding this requirement (if any), the exterior cables in the cable bundle shall be combed straight. Interior cables shall not be combed (i.e. they shall be left "mixed").

Cable in ladder rack on walls: Place larger cable bundles against wall, smaller cable bundles to the inside.

Cable straps: Install cable straps to secure cable bundles to cable runway and other supporting equipment. The use of plastic tie wraps for this purpose is not acceptable. Comply with Division 27 Specification Section *Communications - Equipment Room Fittings*.

3.6 CABLE SLACK

Cable slack in communications rooms and spaces: Store slack by circling cable around communications room in the Cable Runway as shown on the Drawings.

Provide Slack length as follows:

Inside Plant Cable: 10 feet minimum for all cable types (horizontal and backbone)
Outside Plant Cable:

At termination ends:

Copper Backbone Cable: 10 feet minimum
Fiber Backbone Cable: 50 feet minimum

In UCV's

See OUTSIDE PLANT CABLE INSTALLATION below

Where Cable Runway does not exist or where slack storage is not called out on the Drawings, slack shall be stored as follows:

Copper Cable:

Horizontal: Slack shall be stored in a serpentine loop manner, not in the form of a circular “loop” (for performance reasons).
Backbone: Slack shall be stored in circular “loops”.

Fiber Cable: Slack shall be stored in circular “loops”.

Cable slack at the work area outlet: Provide 1 foot of slack. Slack shall be stored in a serpentine loop manner, not in the form of a circular “loop” (for performance reasons).

In cases of extreme congestion, notify the Engineer and await the Engineer’s direction prior to installation.

3.7 OUTSIDE PLANT INSTALLATION

Duct/Direct-Buried:

Mandrels: Prior to installation of cable, each duct shall be cleaned of debris with a wire brush or swab and shall be proven out with a test mandrel of sufficient length to verify the TIA minimum bend radii requirements and with a diameter which is ¼ inch smaller than the inside diameter of the duct. Duct shall be cleaned a minimum of two times in the same direction and swabbed with clean rags until the rag comes out of the conduit clean and dry. Swab away from buildings for duct sections connected to buildings.
Cables shall be installed in strict compliance with the Governing Requirements and manufacturers recommendations. Bending radius, pulling tension, other mechanical stresses, and pulling speed as detailed in the manufactures recommendations and TIA standards shall be strictly observed. Pulling tension shall be monitored for all runs of 300 feet or longer. Acceptable monitoring devices are:

Winch with a calibrated maximum tension
Breakaway link (swivel)
In-line tensiometer

Cable reels shall be set up on the same sides of UCV’s as conduit sections in which cables are to be placed. Reels should be leveled and aligned with conduit sections to prevent twisting of cables during installation into conduits. Cables shall be pulled into conduits from tops of reels in long smooth bends. Cables shall not be pulled into conduits from bottoms of reels. A cable feeder guide (shoe) of suitable dimensions shall be used between the cable reel and the face of the duct to protect the cable and guide it into the duct. As the cables are payed off the reel, they shall be carefully inspected for sheath defects. If defects are found during the pulling operation or if the cable on the reel binds, twists, or does not pay off freely, the pulling operation shall be stopped immediately and the Owner’s representative notified.
Cables of 1-¼ inches or larger diameter shall be equipped with factory installed pulling eyes. Pulling grips are to be used for cables smaller than 1-¼ inches in diameter. Grips with rings to prevent the grips from slipping shall not be beaten into the cable sheath. A ball-bearing based swivel shall be used between the pulling-eyes or grips and the pulling strand.
Once pulling begins, and tension is applied to the cable, the pull shall be continued at a steady rate. If it is necessary to stop the pull at any point, the pull should be stopped but the tension should not be released unless it is necessary to do so.

Cables shall not be placed in ducts other than those specifically indicated on the Drawings. For new ductbank, cables shall be installed in the lowest available conduit in a duct bank, working up as additional cables are installed or as detailed on the Drawings. Where cables are pulled through UCV's, duct selections shall be the same at both ends of UCV's unless specifically noted on the Drawings. Changes in duct selections, especially in elevations, shall be avoided to ensure that no damage occurs to the cable sheaths and that pulling tensions are kept as low as possible.

A sufficient length of cable shall be left in each UCV to properly rack the cable, and to provide for splicing operations which may be required outside of the UCV. In the event that the UCV contains cabling routed directly to a building entrance, a sufficient length of cable entering the building shall be left in the UCV to allow for re-termination in the building without the use of a splice in the event of future cable damage between the UCV and the building. Cables in UCV's shall be racked as soon as practicable and in no case shall racking occur greater than one week after cable installation. Cables in UCV's shall be routed to avoid blocking duct access.

Cables shall be fed into ducts from the end of the duct that creates the least sidewall pressure on a bend during installation (i.e. cable should be fed from the end closest to the bend).

Use pulling compound or lubricant where necessary. Lubricants shall be specifically produced for the installation of telecommunications cable, shall be compatible with the cable jacket material and shall be used in accordance with manufacturer's recommendations. Soap-based lubricants shall not be used. Where cable is pulled through a UCV, the cable shall be re-lubricated prior to feeding into the next duct. Immediately after cables have been installed, exposed cables in UCV's and at termination points shall be cleaned of lubricants using dry rags.

Cable ends shall be sealed and protected with end caps immediately after installation and until terminated in a termination enclosure, in order to prevent moisture entry into the core of filled cables and to prevent damage during installation.

Installation of outdoor rated cable at building entrances shall comply with the *National Electric Code (NEC)* Article 800 "50-ft rule" (i.e. total exposed outdoor rated cable length within a building shall not exceed 50 feet). Where this is not possible due to existing field conditions, the Contractor shall notify the Engineer and await direction prior to cable installation.

Building Entrances: All in-use and spare conduits entering the building from the outside plant shall be sealed to prevent intrusion of water, gases, and rodents.

END OF SECTION 27 10 00

SECTION 27 11 00

COMMUNICATIONS - EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.1 SUMMARY

This Section includes requirements for providing equipment and materials for TIA compliant communications equipment rooms and spaces including, but not limited to, telecommunications rooms, equipment rooms, entrance facilities, server rooms, etc. General requirements for equipment room fittings are covered in Division 27 Specification Section *Communications – General Requirements*.

1.2 RELATED SECTIONS

The requirements of Division 27 Specification Section *Electrical Technology - General Requirements* shall serve as the basis for the requirements of this Section, and are incorporated by reference into this Section.

The requirements of Division 27 Specification Section *Electrical Technology - Grounding and Bonding* shall serve as the basis for the requirements of this Section, and are incorporated by reference into this Section.

1.3 SUBMITTALS

Provide the following per the criteria set forth in Submittals in Division 27 Specification Section *Basic Communications Requirements*:

Product Data
Shop Drawings:

Provide the following for each Communication Room, if: a) Communications Rooms are not shown on the Drawings; b) Communication Rooms are only shown as “Typical” on the Drawings; c) or the Contractor is proposing a deviation to the Drawings:

Wall elevations (all four walls)
Plan view/layout

Provide the following only if elevations have not been shown on the Drawings, or if the Contractor is proposing a deviation.

Wall Field Cable/Jumper Management Elevations, including designation of cable and pair terminations within the wall field.

PART 2 - MATERIALS

2.1 GENERAL

Manufacturer: Racks, frames, cabinets, enclosures, rack cable distribution hardware, cable runway (ladder rack), and other distribution and incidental components shall be manufactured by a single Manufacturer unless specifically stated otherwise. The manufacturer shall be:

Chatsworth Products, Inc. (CPI)
Cooper/B-Line
Middle Atlantic

Part Numbers: Refer to the Equipment Schedule(s) on the Communications Construction Drawings for specific manufacturers and part numbers. If no part number is provided, then any part meeting the manufacturer and requirements specified is acceptable.

Color: Unless otherwise indicated, the color of all cable runway, equipment racks, frame, and cabinets, distribution hardware, and other distribution and incidental equipment shall be:

Black

Seismic Bracing: Equipment shall be seismically braced as required by code. Bracing shall be rigid – non-rigid bracing (chains, cables, etc.) is not acceptable, unless otherwise specified by code. Seismic bracing hardware shall be provided by the manufacturer, or shall be approved or recommended by the manufacturer. Where no manufacturer hardware, approval, or recommendation is available, the seismic assembly shall be approved by a licensed structural engineer.

2.2 CABLE RUNWAY (LADDER RACK)

Cable runway system shall be complete with all fittings, miscellaneous hardware, and other incidental hardware required for a complete and fully fitted system, including but not limited to splice kits, support hangers, rods, and brackets, center supports, j-bolts, foot kits, vertical wall brackets, wall angles, support hardware, grounding hardware, and protective end caps for exposed cable runway ends. Provide as shown on the Drawings or as defined below:

Straight Section (Standard Rung Spacing): Cable runway shall be available in 6 inch, 12 inch, 18 inch, 24 inch widths and shall have runway cross-members (rungs) spaced at 12 inch intervals.

Straight Section (Alternate Rung Spacing): Alternate Rung Spacing Cable runway shall be available in 6 inch, 12 inch, 18 inch, 24 inch widths and shall have runway cross-members (rungs) spaced at alternating 12.5 inch and 13.81 inch intervals. Alternate rung spacing runway is used to simplify vertical alignment of cable runway installed across the top of equipment racks with standard 6 inch vertical cable management sections.

Triangular Support Brackets: Triangular Support Brackets shall be provided for all locations where cable runway is to be mounted on a wall. Triangular Support Brackets shall be sized and provided in quantities according to the width and fully loaded capacity of the cable runway to be supported.

Radius Drop: Radius Drops shall be provided for all locations where cable is to drop from one section of cable runway to another lower section of cable runway, or is to drop from cable runway to equipment racks, frames, or cabinets. Radius Drops shall be either Cross Member or Stringer type according to their application, and sized in widths according required to support their application.

Elevation Kits: Elevation kits shall be provided for all equipment racks and frames where cable runway is routed across the tops of equipment racks and frames and is not mounted at the same height as the tops of the equipment racks or frames. Elevation Kit height shall be sized per the distance between the top of the rack or frame and the cable runway.

Rack-to-Runway Mounting Plate: Mounting Plates shall be provided for all equipment racks and frames where cable runway is mounted directly to the top of equipment racks or frame. Mounting Plate shall be 3 inches wide and sized according to the width of the cable runway to be attached.

Vertical Wall Bracket: Vertical Wall Brackets shall be provided for all locations where cable runway is vertically mounted on the wall(s).

Wall Angle Support: Wall Angle Supports shall be provided for all locations where cable runway stops at walls or where Triangular Support Brackets cannot be utilized due to field conditions. Wall angles shall be sized and provided in quantities according to the fully loaded capacity of the cable runway to be supported.

2.3 EQUIPMENT RACKS, EQUIPMENT FRAMES, SERVER FRAMES AND CABINETS

Equipment shall be free standing and shall be complete and fully fitted with all miscellaneous and incidental hardware required, including but not limited to hardware required for assembly, securing to floor, grounding, and seismic bracing (as required by local codes). Height shall be as shown on the Drawings. Provide as shown on the Drawings and as follows:

Equipment Frames: Equipment frames shall be 19 inch wide with universal alternating hole patterns on both sides of the posts, 3 inch channels, 4 posts, top angles, self-supporting bases, top and bottom extension pans, and assembly hardware.
Server Cabinet: Cabinet shall be 78.8 inches high x 23.94 inches wide x 39.3 inches deep with a 42U rack height, shall be equipped with split rear door with cable access and easy access side panels, and complete with cage nuts for mounting equipment.

2.4 RACK-MOUNT ACCESSORIES

Provide as shown on the Drawings and as follows:

Horizontal Power Strip: Provide as shown on Drawings
Vertical Power Strip: Vertical power strips shall be complete with mounting hardware to mount off from back of vertical cable management sections. Where vertical cable management sections are not used, provide standoff brackets to mount to back of equipment rack/frame posts. Power strip shall be rated at 20 amps and be equipped with a power cord of sufficient length to route to the power receptacle serving the equipment rack/frame.
Storage Drawer: Storage drawers shall be, 5.25 inches (3U) high, and shall be capable of mounting flush with the face of the rack.
Single-sided Shelf: Shelf shall be single sided, with side mount brackets 5.25 inches (3U) high, and shall be capable of mounting flush with the face of the rack.

2.5 CABLE MANAGEMENT

Provide as shown on the Drawings and as follows:

Horizontal Cable Management Panels: Horizontal cable management panels shall be 19 inches wide, complete with section covers, and shall be provided in heights (rack units) as shown on the Drawings.
Vertical Cable Management Sections: Vertical cable management sections shall be complete with double-hinged section covers, “finger” style side cable openings capable of accommodating up 48 patch cords or horizontal cables, shall be single or double sided as shown on the Drawings, and shall be provided in widths and heights as shown on the Drawings.
Upper Transition Tray: Provide as shown on Drawings. Unless shown otherwise on Drawings, upper transition trays shall be mounted at the top of equipment racks, frames and enclosures to route patch cables and jumpers. Upper transition trays shall be 19 inches wide.
Distribution Rings: Provide for all locations where cable or jumpers will be routed on backboards and similar surfaces. Size shall be appropriate to the quantity of cable to be supported, and shall be a minimum of 2 inches in diameter. Rings shall be manufactured by CPI, or equal. Type of ring shall be as follows:

C-Rings (“open” rings): Provide for those cables or jumpers which will likely be subjected to frequent moves, adds, or changes.
D-Rings (“closed” rings): Provide for those cables or jumpers not likely to be subjected to frequent moves, adds, or changes.

2.6 BACKBOARDS

Provide backboards as shown on the Drawings. Backboards shall be ¾ inch exterior grade Douglas Fir A-C plywood, void free, 2440-mm (8 feet) high unless otherwise noted, capable of supporting attached equipment. Width shall be as required to fully cover walls. Backboards shall be as follows:

Backboards shall be treated on all sides with a minimum of two coats of fire retardant, non-conductive, paint (to match the color of the room).

2.7 GROUNDING AND BONDING

Bonding Conductor for Telecommunications (BCT): Provide #6 AWG insulated solid copper conductor (green) to bond all non-current-carrying metal telecommunications equipment and materials to the nearest TGB.

PART 3 - EXECUTION

3.1 GENERAL

Work shall comply with the Governing Requirements as defined in Division 27 Specification Section *Basic Communications Requirements*. Governing Requirements of particular relevance to this Section include, but are not limited to:

TIA 569: Commercial Building Standard for Telecommunication Pathways and Spaces
ANSI 310-D: Cabinets, Racks, Panels and Associated Equipment
TIA 606-A: The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
ANSI/NECA/BICSI 607: Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings
ANSI J-STD-607: Commercial Building Grounding and Bonding Requirements for Telecommunications
TIA 607: Commercial Building Grounding and Bonding Requirements for Telecommunications

Seismic Bracing: Install seismic bracing as required by code.

3.2 CABLE RUNWAY (LADDER RACK)

Cable Runway shall be installed per manufacturer's instructions and shall be installed with flat (rung) side up/out. Install with ends cut square, and reamed to remove burrs and sharp edges. Cap cut ends with manufacturer's recommended caps. Affix cable radius drop outs wherever cable will "waterfall" from one runway elevation to another, or from runway to equipment.

3.3 EQUIPMENT RACKS, EQUIPMENT FRAMES, SERVER FRAMES AND CABINETS

Install equipment complete with all required incidental hardware and materials.

Bond all non-current carrying metal telecommunications equipment and materials to the nearest TGB. Ensure that grounding is provided across all cable runway splices and between cable runway and all equipment racks/frames, etc.

Free Standing Equipment Racks and Frames:

Secure cable runway to equipment racks/frames and to walls as shown on the Drawings. Secure racks/frames to floor per manufacturer's instructions.

Rack-to-Runway Mounting Plate: Secure to cable runway and equipment racks and frames. Mounting plates shall be mounted either parallel or perpendicular, depending upon the orientation of the ladder rack

When installing Vertical Cable Management Sections between equipment racks/frames, install management such that the management trough is as far back as possible between the racks/frames, to ensure a clean/even front side of the rack/frame.
When installing multiple adjacent equipment racks/frames, bolt adjacent racks (and management, where shown) together per manufacturer's instructions to ensure a stable, rigid frame.

Vertical Cable Management Rings/Loops: Provide Vertical Cable Management Rings/Loops at 1-foot intervals for all free standing and wall mount equipment racks, frames, and enclosures which are not equipped with double sided Vertical Cable Management Sections.

3.4 CABLE MANAGEMENT

Distribution rings: Mount at minimum 1 foot intervals.

3.5 BACKBOARDS

Mount backboards on walls in locations shown on the Drawings with base of backboard at +12 inches AFF (unless otherwise noted on the Drawings), with the "A" side exposed. Securely fasten plywood to wall-framing members to ensure that it can support attached equipment.

3.6 GROUNDING AND BONDING

Bonding Conductor for Telecommunications (BCT): Bond all non-current carrying metal telecommunications equipment and materials to the nearest TGB with a bonding conductor.

Route along the shortest and straightest path possible with minimal bends.
Bends shall be sweeping.
Bonding conductors shall be continuous (without splices) and shall be insulated from their support.
Ensure that bonding breaks through paint to bare metallic surface of all painted metallic hardware.

END OF SECTION 27 11 00

SECTION 27 11 19

COMMUNICATIONS - TERMINATION EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

This Section includes requirements for equipment to terminate communications cable in communications equipment rooms and spaces. General requirements for termination equipment are covered in Division 27 Specification Section *Communications - General Requirements.*

1.2 RELATED SECTIONS

The requirements of Division 27 Specification Section *Communications - General Requirements* shall serve as the basis for the requirements of this Section, and are incorporated by reference into this Section.

1.3 SUBMITTALS

Comply with the Submittal portion of Division 27 Specification Section *Basic Communications Requirements*. Provide submittal information for the following:

Product Data

PART 2 - MATERIALS

2.1 GENERAL

Manufacturer: Unless otherwise indicated, equipment in this Section shall be of the same Manufacturer as that specified under Division 27 Specification Section *Communications - General Requirements*.

Part Numbers: Refer to the Equipment Schedule(s) on the Communications Construction Drawings for specific manufacturers and part numbers. If no part number is provided, then any part meeting the manufacturer and requirements specified is acceptable.

2.2 PATCH PANELS

Provide patch panels in sizes and quantities as required to support all cables to be terminated. The sizes and quantities shown on the Drawings are for representative purposes only, and may or may not be the final sizes and quantities required. The Contractor shall provide sizes and quantities as required to support all cables to be terminated.

Copper: Copper patch panels shall be rack mountable and sized as shown on the Drawings. Patch panel connectors shall be 8-position/8-conductor, insulation displacement (IDC), non-keyed, and shall accept modular 8-position/8-conductor plugs. Patch panels shall support a universal (T568A and T568B) wiring pattern, shall meet or exceed the transmission requirements for connecting hardware as specified in the Division 27 Specification Section *Communications - General Requirements* for the Category for which they are rated, shall be equipped with pre-manufactured cable management support bar/strain relief for supporting cables behind the patch panel, and shall be complete with all incidental materials necessary for mounting and installation of the panel and support of the cables which shall be connected to it. Patch panels shall be available in 24-port and 48-port styles.

Horizontal Copper Patch Panels: Provide for terminating copper horizontal cables. Patch panel Category rating shall be the same as that specified under Division 27 Specification Section *Communications - General Requirements*.

Fiber: Fiber patch panels shall be dual purpose, capable of both termination/connectorization and splicing (fusion or mechanical) of fiber in the same enclosure, shall support both regular and high-density connectors, and shall be sized as shown on the Drawings. Fiber patch panels shall consist of enclosures pre-assembled with connector panels, blank connector panels (for unused connector slots), strain relief, splice trays (as required) and splice incidentals. Fiber patch panels shall be complete with bulkheads as required to accommodate all fiber strands within the panel, and filler plates as required for all unused bulkhead slots (see Division 27 Specification Section *Communications - Faceplates and Connectors)*, and with all incidental materials necessary for mounting.

Rack Mount: Rack Mount Patch Panels shall be 19 inches wide and shall be available in 24/48 (1U), 48/96 (2U), and 72/144 (4U) port sizes.

2.3 COPPER TERMINATION BLOCKS

110-Style: Provide IDC connecting clips, designation strips, and labels for each 25 pair strip. Termination blocks shall be provided with or without jumper troughs and with or without legs as required by the mounting application. Label colors shall be per TIA standards. Termination blocks shall be UL listed. Termination blocks shall be provided in the quantities required for complete termination. Provide as shown on the Drawings or as required.

Termination Blocks:

For copper backbone cable connectivity: Termination blocks shall be Category 3 rated or higher. Provide 5 pair IDC connection clips as required.
Wall Mounting Termination Block Frame: Provide wall mountable cable management frames to mount termination blocks on walls. Cable management frames shall consist of a wall mountable universal unit with separate horizontal and vertical pathways.

Provide Termination Blocks without legs.
Jumper troughs are not required (they are built into the frame).

Wall Mounting (for termination blocks to be mounted directly on wall):

Provide Termination Blocks and Jumper Troughs with legs.
Provide Jumper Troughs above and below each 300 pair Termination Block. For single 100 pair Termination Blocks, provide one Jumper Trough above.
Termination Block Distribution Ring Backboards: For termination block wall fields with more than one column of termination blocks, provide a row of Termination Block Distribution Ring Backboards above the columns for the routing of jumper cables from one column to another.

2.4 OTHER TERMINATION EQUIPMENT

Building Entrance Protectors: Provide Building Entrance Protectors (BEP's) for the protection all building-to-building copper cables. Each BEP shall be provided complete with plug-in protector modules. Protector modules shall provide over-voltage and sneak current protection and shall be 4B series. For tail-in/tail-out style protectors, provide tail-in and tail-out lengths as required by the application. Provide in sizes and quantities as shown on the Drawings.

PART 3 - EXECUTION

3.1 GENERAL

Work shall comply with the Governing Requirements as defined in Division 27 Specification Section *Basic Communications Requirements*. Governing Requirements of particular relevance to this Section include, but are not limited to:

TIA - 568: Commercial Building Telecommunications Cabling Standard
TIA 569: Commercial Building Standard for Telecommunication Pathways and Spaces
ANSI 310-D: Cabinets, Racks, Panels and Associated Equipment
TIA 606-A: The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
ANSI/NECA/BICSI 607: Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings
ANSI J-STD-607: Commercial Building Grounding and Bonding Requirements for Telecommunications
TIA - 758: Customer-owned Outside Plant Telecommunications Cabling Standard

3.2 PATCH PANELS

Copper:

Horizontal Patch Panels: Cables shall be terminated sequentially and alphabetically by room number and sequential outlet number (within a room) left to right, from patch panel to patch panel (e.g. ports which terminate outlet cables from room 215A shall be terminated prior to ports which terminate outlet cables from room 220). Use the T568A wiring pattern.

Fiber:

Fiber Patch Panels: Strands shall be connected sequentially left to right and from top to bottom. Terminate singlemode fibers in first available ports and multimode in last available ports.

3.3 COPPER TERMINATION BLOCKS

Terminate cable sequentially across the termination strips. Punch down cable using only the Manufacturer approved impact tool.

Horizontal Termination Blocks: Cables shall be terminated sequentially and alphabetically by room number and sequential outlet number (within a room) left to right, from termination block to termination block (e.g. cables from room 215A shall be terminated prior to cables from room 220). Use the T568A wiring pattern.

Backbone Termination Blocks: Cables shall be terminated by the United States Color Code and sequentially left to right and from top to bottom.

3.4 OTHER TERMINATION EQUIPMENT

Building Entrance Protectors (BEP's): Install BEP's for both ends of outside plant copper cables per manufacturer's instructions. All outside plant copper cables shall be routed through BEP's. Connect each BEP's protector ground lug to the nearest TGB with #6 AWG copper grounding conductor.

END OF SECTION 27 11 19

SECTION 27 13 00

COMMUNICATIONS - BACKBONE CABLING

PART 1 - GENERAL

1.1 SUMMARY

This Section includes requirements for backbone cable within the Communications Cabling System. General requirements for backbone cable are covered in Division 27 Specification Section *Communications - General Requirements.*

1.2 RELATED SECTIONS

The requirements of Division 27 Specification Section *Communications - General Requirements* shall serve as the basis for the requirements of this Section, and are incorporated by reference into this Section.

1.3 SUBMITTALS

Comply with the Submittal portion of Division 27 Specification Section *Basic Communications Requirements*. Provide submittal information for the following:

Product Data

PART 2 - MATERIALS

2.1 GENERAL

Manufacturer: Unless otherwise indicated, equipment and materials in this Section shall be of the same Manufacturer as that specified under Division 27 Specification Section *Communications - General Requirements*.

Part Numbers: Refer to the Equipment Schedule(s) on the Communications Construction Drawings for specific manufacturers and part numbers. If no part number is provided, then any part meeting the manufacturer and requirements specified is acceptable.

2.2 COPPER

General:

Cable shall be multi-pair 24 AWG solid copper conductors insulated with color coded PVC, and shall be sized in pair counts as shown on the Drawings.
Copper cable ratings shall be as specified under Division 27 Specification Section *Communications - General Requirements*.

Inside Plant (Interior): Provide indoor rated cable.

Multi-Pair Backbone: Provide as shown on the Drawings. Cable shall be unshielded.

Outside Plant (Exterior): Provide outdoor rated cable. Cable shall conform to RUS PE-89, shall be single jacketed, shielded, and provided as follows:

For Conduit/Duct Installation: Cable shall be flooded (insulated with filling compound).
For Direct-Buried Installation: Cable shall be armored and flooded (insulated with filling compound).

2.3 FIBER

General: Provide fiber optic cable in quantities, strand counts, and types (singlemode, multimode, or hybrid) as shown on the Drawings. Fiber cable shall be all-dielectric, shall conform to Bellcore and RUS standards, and shall be as further specified under Division 27 Specification Section *Communications - General Requirements*.

Inside Plant (Interior): Provide indoor rated cable. Cable shall be tight buffered.

Outside Plant (Exterior): Provide indoor/outdoor rated cable. Cable shall be loose buffered (loose tube) with a central strength member, and shall be dry cable design with dry water blocking technology that eliminates the need for or use of flooding compound.

PART 3 - EXECUTION

3.1 GENERAL

Provide cross connect wire to Owner.

END OF SECTION 27 13 00

SECTION 27 15 00

COMMUNICATIONS - HORIZONTAL CABLING

PART 1 - GENERAL

1.1 SUMMARY

This Section includes specific requirements for horizontal cable within the Communications Cabling System. General requirements for horizontal cable are covered in Division 27 Specification Section *Communications - General Requirements.*

1.2 RELATED SECTIONS

The requirements of Division 27 Specification Section *Communications - General Requirements* shall serve as the basis for the requirements of this Section, and are incorporated by reference into this Section.

1.3 SUBMITTALS

Comply with the Submittal portion of Division 27 Specification Section *Basic Communications Requirements*. Provide submittal information for the following:

Product Data

PART 2 - MATERIALS

2.1 GENERAL

Manufacturer: Unless otherwise indicated, equipment and materials in this Section shall be of the same manufacturer as that specified under Division 27 Specification Section *Communications - General Requirements*.

Part Numbers: Refer to the Equipment Schedule(s) on the Communications Construction Drawings for specific manufacturers and part numbers. If no part number is provided, then any part meeting the manufacturer and requirements specified is acceptable.

2.2 COPPER

Horizontal Cable: Cable shall be 4 pair UTP, solid copper conductors insulated with color coded PVC. Copper cable Category rating shall be the same as that specified under Division 27 Specification Section *Communications - General Requirements.*

Color shall be blue.

PART 3 - EXECUTION

3.1 THIS SECTION NOT USED

END OF SECTION 27 15 00

SECTION 27 15 43

COMMUNICATIONS - FACEPLATES AND CONNECTORS

PART 1 - GENERAL

1.1 SUMMARY

This Section includes requirements for faceplates and connectors within the Communications Cabling System. General requirements for faceplates and connectors are covered in Division 27 Specification Section *Communications - General Requirements.*

1.2 RELATED SECTIONS

The requirements of Division 27 Specification Section *Communications - General Requirements* shall serve as the basis for the requirements of this Section, and are incorporated by reference into this Section.

1.3 SUBMITTALS

Comply with the Submittal portion of Division 27 Specification Section *Basic Communications Requirements*. Provide submittal information for the following:

Product Data

PART 2 - MATERIALS

2.1 GENERAL

Manufacturer: Unless otherwise indicated, equipment in this Section shall be of the same Manufacturer as that specified under Division 27 Specification Section *Communications - General Requirements*.

Part Numbers: Refer to the Equipment Schedule(s) on the Communications Construction Drawings for specific manufacturers and part numbers. If no part number is provided, then any part meeting the manufacturer and requirements specified is acceptable.

2.2 FACEPLATES

General: Provide faceplates for outlets in the locations and gang counts as shown on the Drawings or as specified below. Faceplates shall be complete with blank inserts/fillers for covering unused connector openings. Faceplates and fittings shall be dimensionally suitable for securely mounting connectors, providing a snug and sure fit – loose connectors are not acceptable. Faceplates shall be complete with port identification labels, and shall be provided with appropriate adapters, fittings and adapters as required.

Color: The color of non-stainless steel faceplates shall be coordinated with the Owner and Architect prior to purchase and delivery unless specified below.

Faceplates/Fittings:

For wall-mount telephone locations:

Faceplates shall be brushed stainless steel with stainless steel mounting lugs suitable for mounting wall-mount telephones. Faceplates shall be dimensionally suitable for securely mounting 8-position/8-conductor IDC (RJ45 style) connectors.

For specialized mounting requirements (including but not limited to furniture, furniture "pop-ups" and enclosures, floor-boxes, poke-throughs, surface mounted raceway, etc.):

Provide faceplates and fittings as required to support the specialized mounting. Faceplates and fittings shall be manufactured specifically for the equipment that they are to be mounted into ("general purpose" faceplates field modified for the specialized use are not acceptable unless specifically noted otherwise on the Drawings). Faceplates and fittings shall be approved by both the equipment manufacturer and the communications cabling system manufacturer, and shall be coordinated and verified compatible by the Contractor, equipment manufacturer and cabling system manufacturer prior to procurement and delivery. The provision of the correct faceplates and fittings for use in specialized mounting requirements is the sole responsibility of the Contractor.

For walls and other non-specialized locations:

Faceplates shall be plastic and capable of flush-mounting connectors.

For Wireless Access Point (WAP) and Security Camera (SC) locations:

Provide surface housing outlet box. Surface housing shall be dimensionally suitable for securely mounting 8-position/8-conductor IDC (RJ45 style) connectors.

Provide blank faceplates, matching those faceplates in use, for all unused Communications Systems Outlets including, but not limited to wall mounted Back Boxes and empty gangs in Floor Boxes and Poke-Thrus.

2.3 CONNECTORS

General: Connectors shall meet or exceed the TIA standards and as called for in the Governing Requirements.

Horizontal:

Copper: Copper connectors shall be 8-position/8-conductor, insulation displacement connector (IDC), non-keyed, and shall accept modular 8-position/8-conductor plugs. Connectors shall have a universally color-coded wiring pattern for both T568A and T568B. Copper connectors Category rating shall be the same as that specified under Division 27 Specification Section *Communications - General Requirements*. Provide 25 additional connectors as spares to Owner.

Color shall be blue.

Backbone:

Fiber: Fiber connectors shall be complete with bulkheads, adapters and adapter plates where required for mounting in fiber patch panels. Connectors shall be ultra polished (UPC), ceramic and shall be LC, specific to the fiber core size to be connectorized.

For multimode fiber, provide field installable connectors.

PART 3 - EXECUTION

3.1 FACEPLATES

Install all faceplates level and perpendicular to the floor. If long side of existing outlet box is mounted horizontal, then rotate faceplate counter-clockwise.

3.2 CONNECTORS

Horizontal:

Copper: Terminate connectors using the T568A wiring pattern at both ends of the cable.

Backbone:

Copper:

Comply with Division 27 Specification Section *Communications - Termination Equipment*.

Fiber: Connectorize fiber strictly according to Manufacturers instructions using manufacturer specified tools and termination kits. All fiber strands within a cable shall be connectorized – the installation of “dark fiber” is not acceptable unless shown otherwise on Drawings.

Connectors: Visually verify connectorization after installation with a minimum 200x magnification microscope to ensure that no physical damage has occurred during the installation process.
Pigtails: Connect pigtails to fiber with fusion splicing – mechanical splicing is not acceptable.

END OF SECTION 27 15 43

SECTION 27 16 19

COMMUNICATIONS - PATCH CORDS

PART 1 - GENERAL

1.0 SUMMARY

This Section includes specific requirements for communications patch cords within the Communications Cabling System. General requirements for patch cords are covered in Division 27 Specification Section *Communications - General Requirements.*

1.1 RELATED SECTIONS

The requirements of Division 27 Specification Section *Communications - General Requirements* shall serve as the basis for the requirements of this Section, and are incorporated by reference into this Section.

1.2 SUBMITTALS

Comply with the Submittal portion of Division 27 Specification Section *Basic Communications Requirements*. Furnish submittal information for the following:

Product Data

PART 2 - MATERIALS

2.0 GENERAL

Manufacturer: Unless otherwise indicated, equipment and materials in this Section shall be of the same manufacturer as that specified under Division 27 Specification Section *Communications - General Requirements*.

Part Numbers: Refer to the Equipment Schedule(s) on the Communications Construction Drawings for specific manufacturers and part numbers. If no part number is provided, then any part meeting the manufacturer and requirements specified is acceptable.

2.1 COPPER PATCH CABLES

Furnish copper patch cables for modular copper cross-connects. Patch cables shall be pre-manufactured (factory-terminated), stranded UTP, with 8-pin modular plugs.

Patch cables shall be 4-pair with snagless modular plugs. Copper patch cables Category rating shall be the same as that specified under Division 27 Specification Section *Communications - General Requirements.* Color shall be blue. Furnish as follows:

For Work Area Outlets: Furnish one (1) 5 foot (1.5m) patch cable per horizontal cable installed.
For Communications Rooms: Furnish one (1) 15 foot (5m) patch cable per horizontal cable installed.

2.2 FIBER PATCH CABLES

Fiber patch cables shall be pre-manufactured with connectors (factory-terminated) at both ends. Furnish as follows:

For Communications Rooms:

Multimode: Furnish (1) 30 foot (10m) 62.5/125 µm multimode Duplex LC patch cables. Color shall be Orange.

PART 3 - EXECUTION

3.0 GENERAL

Furnish and install patch cables.

3.1 PATCH CORD INSTALLATION

Data patch cords being installed to ports on equipment must not cross the center of the port section on the equipment.

Patch cords being installed to jacks on patch panels must not cross the center of the patch panel.

A small drip loop is required for troubleshooting and tracing patch cords

Coordinate patch cord routing with Owner prior to installation of patch cords.

END OF SECTION 27 16 19

SECTION 27 17 10

COMMUNICATIONS - IDENTIFICATION

PART 1 - GENERAL

1.1 SUMMARY

This Section includes requirements for identification/administration of the Communications Cabling System.

1.2 SUBMITTALS

Comply with the Submittal portions of Division 27 Specification Sections *Basic Communications Requirements* and *Communications - General Requirements*. Provide submittal information for the following:

Identification and Administration (see *Part 2 – Materials: Identification and Administration* herein):

Provide a list of proposed hand-carried or computer software based identification/label makers, and a list of proposed materials for identifiers/labels. Provide actual samples of labels to be created for each system component to be labeled.

PART 2 - MATERIALS

2.1 IDENTIFICATION AND ADMINISTRATION

Identifiers (labels) shall be as recommended in TIA 606-A, unless noted otherwise herein.

Labels shall be permanent (i.e. not subject to fading or erasure) and permanently affixed. Handwritten labels are not acceptable.

For identification of materials and equipment interior to the facility:

For cables: Labels shall be created by a hand-carried label maker or an equivalent computer/software-based label making system.

For horizontal cables: Labels shall include a clear vinyl adhesive wrapping applied over the label in order to permanently affix the label to the cable. Using transparent tape to affix labels to cables is not acceptable.
For backbone cables: Labels shall be affixed or engraved on hard plastic markers.

For equipment (racks, frames, cabinets, enclosures, etc.): Provide engraved nameplates.

For identification of materials and equipment in the outside plant:

Labels shall be waterproof (even when submerged) and engraved on hard plastic markers. Lettering shall be black, markers shall be white.

PART 3 - EXECUTION

3.1 GENERAL

Work shall comply with the Governing Requirements as defined in Division 27 Specification Section *Basic Communications Requirements*. Governing Requirements of particular relevance to this Section include, but are not limited to:

Identification and Administration:

TIA 606-A: The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings

The Contractor shall pay particular attention to and comply with the following Owner Governing Requirements:

3.2 IDENTIFICATION AND ADMINISTRATION

General

The Contractor is solely responsible for the completeness, accuracy, and placement of identifiers (labels). Incorrectly identified components are the sole responsibility of the Contractor.

Where questions arise regarding the correct identifier for a given component, the Contractor shall notify the Owner and Engineer and await direction prior to proceeding.

The Contractor shall install identifiers where indicated and at locations for best viewing convenience without interfering with the operation and maintenance of equipment.
The Contractor shall coordinate names, abbreviations, colors, and other designations with the corresponding designations indicated in the Construction Documents and as required by codes and standards.
The Contractor shall use consistent identifiers throughout the Project.
The Contractor shall clean surfaces of dust, loose material, and oily films before applying self-adhesive identifiers.
Two weeks prior to a particular component or group of components being labeled, the Contractor shall review the proposed identification scheme, label(s), and procedure for affixing label(s) with the Owner and Engineer. Contractor shall not proceed with labeling until the Owner and Engineer have approved the proposed identification scheme, label(s), and procedure for affixing label(s).
The Contractor shall physically verify that the component to be identified matches the label to be affixed, prior to affixing the label.

Communications Cable Color Coding: Industry standard color coding shall be applied to all cable termination fields. The same color shall always be applied to both ends of any given cable. Cross-connections are generally made between termination fields of different colors. The color may be applied to the backboard behind the termination equipment, may be the color of a cover on the termination equipment, or may be the actual color of the insert label on the termination equipment. The following color code shall be used:

Orange: Identification of the telecommunication service (telephone company) demarcation point.
Green: Identification of network connections on the customer side of the demarcation point.

White: Identification of first-level backbone in the building containing the main cross-connect, or may be used to identify the second-level backbone in buildings not containing the main cross-connect.
Gray: Identification of the second-level backbone in the building containing the main cross-connect.
Blue: Identification of the horizontal cables. A blue color coding is only required at the closet end of the cable, not at the outlet end of the cable.
Brown: Identification of inter-building backbone cables.
Yellow: Identification of auxiliary circuits, alarms, maintenance, security, and other miscellaneous circuits.
Red: Identification of key telephone systems.

Cable Types shall be used for identification and labeling purposes, and shall be as follows:

S: Horizontal cable - copper (Category 3, 5E, 6, 6E, coax, etc. – inside plant only)
SF: Horizontal cable - fiber (typically multimode – inside plant only)
SM: Singlemode fiber backbone (inside and outside plant)
MM: Multimode fiber backbone (inside and outside plant)
H: Hybrid/composite singlemode and multimode fiber backbone (inside and outside plant)
C: Copper backbone used for voice grade communications (inside and outside plant)
D: Copper backbone used for data grade communications (inside and outside plant)
CX: Coax backbone (inside and outside plant)

Component Identification (Labels):

Telecommunications Rooms: Telecommunications Rooms shall be labeled as shown on the Drawings. In general, Telecommunications Rooms are labeled by floor and direction. For example, the north Telecommunications Room on the first floor shall have the label "1N."
Equipment Racks, Frames, Cabinets, Enclosures, etc.: Equipment shall be labeled sequentially within a given closet and as shown on the Drawings. Labels shall be of the form "EX" where "E" stands for "(R)ack", "(F)rame", "(C)abinet", or "(E)nclosure" and "X" is the sequential equipment number within a given closet. For example: The first rack in a given Telecommunications Room would have the label "R1", the second "R2" and so on.
Inside Plant Cables and Equipment:

Outlets:

Faceplate: Faceplates shall identify the room in which the outlet resides, Telecommunications Room at which the outlet terminates, and the sequential number of the outlet with the room, separated by a dash (" - "). For example, the fourth faceplate within room 110 which terminates in Telecommunications Room "1N" shall have the label "110-1N-4".

The faceplate sequential number within the room shall be calculated by first numbering the faceplates along the outside walls in a clockwise direction from the doorway, and then proceeding to outlets in the middle of the room.

Ports: Ports shall be labeled sequentially by number, left to right, top to bottom. For example, a four port outlet shall have port labels as follows:
1 2
3 4

Cables:

Label Location: Labels shall be affixed at each end of the cable.
Horizontal Cables: Horizontal cables shall be labeled with the same label as the termination block port to which the horizontal cable is connected in the Telecommunications Room.
Backbone Cables: Cables shall be labeled sequentially by number, for each backbone Cable Type within the building. Labels at each end of the cable shall identify the Telecommunications Room at the “far end” of the cable, and shall identify the sequential number of the cable, by Cable Type, within the building, separated by a dash (“ - ”). For example, the label on the near end of the fourth multimode fiber cable (within the building) with a far end terminating in Telecommunications Room 2N shall have the label “2N-MM4.”

Termination Blocks:

For Backbone Distribution: Termination blocks used for backbone distribution shall have a single label affixed above the entire termination block wall field which reads “Backbone Cables”.

Termination Block (110-style)

i. Pairs: Pairs shall be labeled sequentially (left to right). Pair labels shall be continuous from block to block. For example, the first 300 pair block shall have pairs labeled “001” through “300”, the second shall have pairs labeled “301“ through “600”, etc.
ii. Rows: Rows shall be labeled sequentially and shall continue (without restarting) from block to block. For example, the first 300 pair block shall have rows labeled 1 through 12, the second 13 through 24, etc. Each row shall clearly identify the backbone cable terminating on the row, using the “far end” identifier for the cable.

Patch Panels:

General: Patch panels shall be labeled sequentially within a Telecommunications Room, by Cable Type, top to bottom, left to right. For example, the 4th horizontal copper patch panel shall have the label “S4.”
Horizontal Copper Patch Panels:

Ports shall be labeled with the room number, sequential outlet (faceplate) number, and the sequential horizontal port number, each separated by a period (“.”). For example, the patch panel port which terminates the fourth outlet and third port within room 215 shall have the label “215.4.3”.

Components Specific to Fiber Patch Panels:

Connector Panels/Adapter Plates: Connector panels are typically pre-labeled by the manufacturer with labels such as “A”, “B”, etc. or “1”, “2”, etc. For connector panels which are not pre-labeled, connector panel labels shall be of the form “X” where “X” is an alphabetical letter identifying the sequential connector panel within the patch panel.

Outside Plant Cables and Equipment:

Copper Building Entrance Protectors:

Campus Backbone Distribution:

Outside the panel: BEP's shall be labeled on the outside with one-inch lettering which clearly indicates the originating building(s).
Inside the panel: The BEP shall have a label which details for each cable terminating in the panel: the cable identifier, the originating building, intermediary UCV's (vaults, manholes, etc.) between the originating building and the building at which the patch panel is located, the cable count, and any pairs cut dead.

Outside Horizontal Distribution:

Station Entrance Protectors: Label with the horizontal outlet identifier (see Outlets above).

Cable: Labels at each end of the cable shall identify the Building and Telecommunications Room at the far end, separated by a dash (" - "), and shall identify the sequential number of the cable, by Cable Type, for cables between the two buildings, separated by a period (" - "). For example, the label on the near end of the second singlemode fiber cable between buildings A and B, with a far end terminating in Telecommunications Room 3E of Building B, shall have the label "B-3E-SM2."

Cable labels shall be provided in all intermediary UCV's between origination and destination. Cables shall be labeled immediately as they enter a UCV and again just prior to exiting the UCV
Copper Cables: In addition to the above, copper cables shall be labeled with the cable gauge, the pair count, dead pairs at time of installation, and cut length.
Fiber Cables: In addition to the above, fiber cables shall be labeled with the fiber type(s), strand count(s), strands not in use ("dark") at time of installation , and cut length.

Fiber Patch Panels:

Identifiers shall comply with the requirements of Inside Plant Cables and Equipment, Patch Panels, above.
Patch panel shall have an additional single label which details the following information for all cables terminating in the panel: The cable identifier, originating building, originating telecommunications room, intermediary UCV's (vaults, manholes, etc.) between the originating building and the building at which the patch panel is located, the fiber type (62.5/125um multimode, 50/125um multimode, singlemode, hybrid (composite), the strand counts and any strands not in use ("dark") at time of installation.

Outlet References and Labels Spreadsheet

A Outlet Reference Spreadsheet (a sample of which is attached to the end of this Specification Section) shall be maintained by the Contractor throughout construction. This spreadsheet shows outlet and patch panel port names, based upon the outlets shown on the Drawings, and is intended for the Owner's use for patching and cross-connecting purposes during move-in.

The Contractor shall maintain the electronic copy of the spreadsheet with up-to-date as-built information on a minimum two week interval throughout construction.

The Contractor shall provide the Owner or Engineer an electronic copy of the up-to-date spreadsheet upon request during the course of construction.

The Contractor shall be solely responsible for the completeness and accuracy of the spreadsheet throughout construction and upon delivery to the Owner and Engineer.
Pre-Substantial Completion: Three weeks prior to Substantial Completion, the Contractor shall submit the final version of the spreadsheet to the Owner and Engineer. The final version of the spreadsheet shall incorporate all as-built information and any changes from the original Drawings.

Station References Spreadsheet (Sample)

TR - 3

Station Reference				Labeling												
Room Number	Room Description/Name	Station Number	Total Ports	Patch Panel Ports (by Station Port)						Station	Station Ports*					
				1	2	3	4	5	6		1	2	3	4	5	6
344	Open Office	1	3	344.1.1	344.1.2	344.1.3	-	-	-	344 - 3 - 1	1	2	3	-	-	-
344		2	3	344.2.1	344.2.2	344.2.3	-	-	-	344 - 3 - 2	1	2	3	-	-	-
345	Open Office	1	3	345.1.1	345.1.2	345.1.3	-	-	-	345 - 3 - 1	1	2	3	-	-	-
345		2	3	345.2.1	345.2.2	345.2.3	-	-	-	345 - 3 - 2	1	2	3	-	-	-
345		3	3	345.3.1	345.3.2	345.3.3	-	-	-	345 - 3 - 3	1	2	3	-	-	-
345		4	3	345.4.1	345.4.2	345.4.3	-	-	-	345 - 3 - 4	1	2	3	-	-	-
345		5	3	345.5.1	345.5.2	345.5.3	-	-	-	345 - 3 - 5	1	2	3	-	-	-
345		6	3	345.6.1	345.6.2	345.6.3	-	-	-	345 - 3 - 6	1	2	3	-	-	-
346		1	3	346.1.1	346.1.2	346.1.3	-	-	-	346 - 3 - 1	1	2	3	-	-	-
346		2	3	346.2.1	346.2.2	346.2.3	-	-	-	346 - 3 - 2	1	2	3	-	-	-
347	Work Area	1	3	347.1.1	347.1.2	347.1.3	-	-	-	347 - 3 - 1	1	2	3	-	-	-
348	Open Office	1	3	348.1.1	348.1.2	348.1.3	-	-	-	348 - 3 - 1	1	2	3	-	-	-
348		2	3	348.2.1	348.2.2	348.2.3	-	-	-	348 - 3 - 2	1	2	3	-	-	-
348		3	3	348.3.1	348.3.2	348.3.3	-	-	-	348 - 3 - 3	1	2	3	-	-	-
348		4	3	348.4.1	348.4.2	348.4.3	-	-	-	348 - 3 - 4	1	2	3	-	-	-
348		5	3	348.5.1	348.5.2	348.5.3	-	-	-	348 - 3 - 5	1	2	3	-	-	-
348		6	3	348.6.1	348.6.2	348.6.3	-	-	-	348 - 3 - 6	1	2	3	-	-	-
349	Copy/Print	1	2	349.1.1	349.1.2	-	-	-	-	349 - 3 - 1	1	2	-	-	-	-
349		2	3	349.2.1	349.2.2	349.2.3	-	-	-	349 - 3 - 2	1	2	3	-	-	-
349		3	2	349.3.1	349.3.2	-	-	-	-	349 - 3 - 3	1	2	-	-	-	-
350	Break	1	2	350.1.1	350.1.2	-	-	-	-	350 - 3 - 1	1	2	-	-	-	-
351	Open Office	1	3	351.1.1	351.1.2	351.1.3	-	-	-	351 - 3 - 1	1	2	3	-	-	-
351		2	3	351.2.1	351.2.2	351.2.3	-	-	-	351 - 3 - 2	1	2	3	-	-	-
351		3	3	351.3.1	351.3.2	351.3.3	-	-	-	351 - 3 - 3	1	2	3	-	-	-
351		4	3	351.4.1	351.4.2	351.4.3	-	-	-	351 - 3 - 4	1	2	3	-	-	-
351		5	3	351.5.1	351.5.2	351.5.3	-	-	-	351 - 3 - 5	1	2	3	-	-	-
351		6	3	351.6.1	351.6.2	351.6.3	-	-	-	351 - 3 - 6	1	2	3	-	-	-
352	Wireless Access	1	1	352.1.1	-	-	-	-	-	352 - 3 - 1	1	-	-	-	-	-
352	Open Office	2	3	352.2.1	352.2.2	352.2.3	-	-	-	352 - 3 - 2	1	2	3	-	-	-
353	Storage	1	2	353.1.1	353.1.2	-	-	-	-	353 - 3 - 1	1	2	-	-	-	-
353		2	2	353.2.1	353.2.2	-	-	-	-	353 - 3 - 2	1	2	-	-	-	-
353		3	2	353.3.1	353.3.2	-	-	-	-	353 - 3 - 3	1	2	-	-	-	-
354		1	3	354.1.1	354.1.2	354.1.3	-	-	-	354 - 3 - 1	1	2	3	-	-	-
354		2	3	354.2.1	354.2.2	354.2.3	-	-	-	354 - 3 - 2	1	2	3	-	-	-
361	Open Office	1	3	361.1.1	361.1.2	361.1.3	-	-	-	361 - 3 - 1	1	2	3	-	-	-
361		2	3	361.2.1	361.2.2	361.2.3	-	-	-	361 - 3 - 2	1	2	3	-	-	-
361		3	3	361.3.1	361.3.2	361.3.3	-	-	-	361 - 3 - 3	1	2	3	-	-	-
362		1	3	362.1.1	362.1.2	362.1.3	-	-	-	362 - 3 - 1	1	2	3	-	-	-
362		2	3	362.2.1	362.2.2	362.2.3	-	-	-	362 - 3 - 2	1	2	3	-	-	-
363	Open Office	1	3	363.1.1	363.1.2	363.1.3	-	-	-	363 - 3 - 1	1	2	3	-	-	-
363		2	3	363.2.1	363.2.2	363.2.3	-	-	-	363 - 3 - 2	1	2	3	-	-	-
364	Flr Box/Poke Thru	1	2	364.1.1	364.1.2	-	-	-	-	364 - 3 - 1	1	2	-	-	-	-
364	Wireless Access	2	1	364.2.1	-	-	-	-	-	364 - 3 - 2	1	-	-	-	-	-

END OF SECTION 27 17 10

SECTION 27 17 20

COMMUNICATIONS - TESTING

PART 1 - GENERAL

1.1 SUMMARY

This Section includes requirements for testing of the Communications Cabling System.

1.2 SUBMITTALS

Provide the following per the criteria set forth in Submittals in Division 27 Specification Section *Basic Communications Requirements*:

Other:

Testing (see *Part 2 – Testing* herein):

Provide a list of proposed test equipment for use in verifying the installation of the communications cabling system.

Provide for each testing device:

Manufacturer and product number.
Manufacturer documentation showing date and outcome of last re-calibration. Testing device shall have been re-calibrated within the manufacturer's recommended recalibration period.
Manufacturer documentation showing software revision.
Software revision shall be most current revision available for the device and shall be based upon the most current TIA testing guidelines.
Patch cords and other specialized components.

Provide proposed test result forms.
Provide the calculated optical fiber cable loss budget for each optical fiber cable in the system (see Part 3 – Execution: Testing herein)

PART 2 - MATERIALS

2.1 TESTING

General

Testing of the systems shall be in accordance with the manufacturer's recommendations and with the Governing Requirements.
Test reports shall be complete and in accordance with the appropriate Governing Requirements.
Where testing discloses deficiencies in the work, the Contractor shall rework, repair, or replace equipment and systems found deficient. The Contractor shall continue remedial measures and retesting until satisfactory results are obtained. Remedial measures and retesting shall be at no additional cost to the Owner.
Testing of product or equipment prior to installation shall include performance testing to establish the applicability of equipment for its intended purpose. The Contractor shall:

Establish the required test procedures from required Governing Requirements and manufacturer's recommendations.
Provide necessary test equipment, power, and consumables to perform the test.
Notify the Engineer of test schedule(s) at least one week in advance.

Perform test.
Provide test result documentation to the Engineer.

Final testing and start-up of product, equipment, and systems shall include establishing proper capacity, operation, maintenance, and compliance with Governing Requirements. The Contractor shall:

Provide the services of manufacturer's representatives for systems to be tested and started up.
Establish the required test procedures from required Governing Requirements and manufacturer's recommendations.
Provide necessary test equipment, power, and consumables to perform the test.
Notify the Engineer of test schedule(s) at least one week in advance.
Perform tests and start-up functions.
Provide documentation of test results and fully operational systems to the Engineer.

Test records shall be provided on a form approved by the Engineer.

Systems Specific: Test shall be performed for each of the following systems as follows:

Communications Cabling System

Test records:

Each cable in the system shall be tested. Test result forms shall include the cable identifier, tests performed, outcome of tests and indication of errors found, cable length, retest results, and name and signature of technician completing the tests. Test result forms shall be provided to the Owner and Engineer for review and acceptance.
Test records for each cable within the system shall be printed directly from the tester and shall be submitted in paper form (in a binder) and on compact disk to the Owner and Engineer for review. Handwritten test results will not be accepted.

Testing Devices: Testing devices shall be capable of storing and printing test records for each cable within the system.

For copper cables:

Testing device shall be a TIA TSB-95 Level 3 testing instrument re-calibrated within the calibration period recommended by the manufacturer, with the most current software revision based upon the most current TIA testing guidelines.

For fiber cables:

Testing devices shall consist of a light source/power meter with a stabilized light source for end-to-end attenuation testing and an Optical Time Domain Reflectometer (OTDR) for testing on the reel, for continuity and quality testing, for accurately determining cable length, and for locating and correcting problems noted during attenuation testing. Testing equipment shall be calibrated and traceable to the National Institute for Standards and Technologies (NIST), with an operating range of 850 +/- 30 nm or 1300 +/- 20 nm for multimode testing in accordance with TIA -526-14 for multimode testing, and an operating range of 1310 +/- 10nm or 1550 +/- 20 nm in accordance with TIA -526-7 for singlemode testing.

To ensure quality connectorization, a microscope of not less the 200x magnification shall be used to visually inspect connectors and splices after installation.

PART 3 - EXECUTION

3.1 GENERAL

Work shall comply with the Governing Requirements as defined in Division 27 Specification Section *Basic Communications Requirements*. Governing Requirements of particular relevance to this Section include, but are not limited to:

Testing:

TIA - 455: Fiber Optic Test Standards
TIA - 526: Optical Fiber Systems Test Procedures
TIA - 568 Commercial Building Telecommunications Cabling Standard
IEEE 802.3 (series): Local Area Network Ethernet Standard, including the IEEE 802.3z Gigabit Ethernet Standard

3.2 TESTING

General

Test devices shall be in calibration throughout the testing period. Tests performed on equipment without up to date calibration shall be rejected and shall be repeated at no additional cost to the Owner.
The Contractor shall notify the Engineer and Owner at least one week in advance of each type of test to be conducted. The Owner or Engineer may, at their discretion, witness all testing.

The Owner and Engineer shall be invited to attend and inspect the first instance of each type of test to be conducted. Tests conducted prior to first inspection shall be at the sole risk of the Contractor, and as such are subject to rejection. Such tests will be repeated at no additional cost to the Owner.

Systems Specific Testing:

Communications Cabling System

All interior (inside plant) and exterior (outside plant) fiber cables shall be tested on the reel upon delivery to the job site prior to installation.

Test results shall be permanently affixed to the reel and a copy given to the Owner and Engineer for review prior to installation.
Testing shall demonstrate compliance with the factory test results as shipped with the reel. Cables that fail to pass shall not be installed, and the Contractor shall replace the cable at no additional cost to the Owner. Repair of damaged cable is not acceptable.

Test the communications cabling system for compliance to the Governing Requirements and all applicable standards as follows:

Visually inspect all labels at the outlet locations (faceplates/ports), patch panels/ports, and on each end of each cable to ensure that all cables and equipment are correctly identified.
Copper Cable:

For Horizontal Distribution: Test each copper horizontal cable, all pairs. To the extent possible, tests shall be performed with building electrical systems fully powered on (i.e. Lights, HVAC, etc.).
Test each end-to-end Permanent Link (the entire link from the connector at the outlet to the connector or termination in the telecommunications closet) utilizing sweep tests, for Wire map (continuity), length, propagation delay/delay skew, attenuation (insertion loss), return loss, near-end cross talk (NEXT) loss, Equal Level Far-End Crosstalk (ELFEXT), attenuation-to-crosstalk ratio (ACR), power sum NEXT (PSNEXT) and power sum ELFEXT (PSELFEXT). Each cable shall be tested in both directions.
Test results shall demonstrate compliance with:
The criteria specified in TIA 568 for Category 6A cables
The criteria specified in IEEE 802.3z (1000Base-X Gigabit Ethernet)

For Backbone Distribution (inside and outside plant): Test each cable, all pairs, for length, shorts, opens, continuity, polarity reversals, transposition (wire map), and the presence of AC voltage.
Test entire channel, from termination block to termination block.
Test results shall demonstrate compliance with:
The criteria specified in TIA 568 for Category 3 cables

Fiber Cable:

Prior to testing, the cable loss budget shall be calculated by the Contractor for each optical fiber cable and shall be clearly shown on the test documentation. Maximum loss shall be calculated by the following formula, assuming no splices:
For Backbone Distribution (inside and outside plant):
Max Loss = (allowable loss/km) * (km of fiber) + (0.4db) * (# of connectors)

A mated connector-to-connector interface is defined as a single connector for the purposes of the above formula.

A given fiber cable shall not exceed its calculated maximum loss (per the above formula).

Test all strands. Testing shall consist of a bi-directional end-to-end Optical Transmission Loss Test Instrument trace performed per TIA 455-61 and a bi-directional end-to-end power meter test performed per TIA 455-53A.

Loss numbers shall be calculated by taking the sum of the two bi-directional measurements and dividing that sum by two.

All backbone fiber cables shall be tested with an OTDR in addition to attenuation testing performed with a power meter.

The number of samples (averages) for each OTDR test shall be such that the noise amplitude is significantly less than the smallest loss of any component under test.

Multimode fiber testing shall incorporate use of a mandrel wrap of fiber jumper to induce macro bends in the fiber.

Test measurements shall be provided as follows:

For Multimode Cable: Test at both 850 and 1300nm.

For Singlemode Cable: Test at both 1310 and 1550nm.

Test results shall demonstrate compliance with:

The criteria specified in TIA-568A Annex H.

The Contractor's calculated loss budget above.

The criteria specified in IEEE 802.3z (1000Base-X Gigabit Ethernet)

In addition to the above, tests performed shall be both those recommended and mandated by the communications cabling system Manufacturer.
Cables and equipment that do not pass shall be identified to the Engineer. The source of the non-compliance shall be determined, corrected or replaced, and re-tested at no additional cost to the Owner. Provide new test results to the Engineer in the same manner as above.

In addition to the above, if it is determined that a cable is at fault, the contractor shall remove the damaged cable and replace it with a new cable. Cable "repairs" are not acceptable. The procedure for removing the cable shall be as follows:

Prior to removal of the damaged cable and re-pull of the new cable:

Any cables which are in the same conduit, duct or innerduct as the damaged cable shall be tested, regardless of whether or not they are new cables installed as part of this project or existing cables installed prior to this project.

If the damaged cable is a backbone or outside plant cable:

The Owner and Engineer shall be informed of the schedule for the removal and re-pull.

The new cable shall be tested on the reel prior to installation.

All test results shall be provided to the Engineer for approval.

The damaged cable shall be removed and the new cable shall be pulled in.

After the removal of the damaged cable and re-pull of the new cable:

The new cable shall be tested.

Any cables which are in the same conduit, duct or innerduct as the damaged cable shall be tested, regardless of whether or not they are new cables installed as part of this project or existing cables installed prior to this project.

All test results shall be provided to the Engineer for approval.

Existing cables which are in the same conduit, duct or innerduct as the damaged cable, and which are damaged by the extraction and re-pull process, shall be removed and replaced at no additional cost to the Owner.

Existing damaged cables that are replaced shall be subject to the testing procedures of this Section in its entirety.

END OF SECTION 27 17 20

SECTION 27 41 16
AUDIO VIDEO SYSTEMS

PART 1 - GENERAL

1.0 RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

Division 26 Electrical

Division 27 Communications

1.1 REFERENCE TO OWNER'S GENERAL CONDITIONS

The Owner's General Conditions shall be considered part of this Specification. Unless this Section contains statements, which are more definitive or more restrictive than those contained in the Owner's General Conditions, this Specification shall not be interpreted as waiving or overruling any requirements expressed in the General Conditions.

1.2 RELATED WORK

AV Contractor shall coordinate with Electrical Contractor on raceway/junction box locations for audiovisual equipment and routing of audio, video, control, and power cables/raceway from equipment, terminal and pull boxes to system equipment racks.

Electrical infrastructure (j-boxes, conduit, Etc.) for AV systems shown on AV drawings is the responsibility of the Div. 26 Electrical Contractor.

Equipment and materials provided and installed by others, unless otherwise shown in this Section or the Drawings, shall include but are not limited to:

Electrical Outlets

Conduit, Raceway and Cable Tray

Junction Boxes

Telecommunications Outlets

Lighting Control Devices

1.3 DEFINITIONS

The following shall serve as general identifiers as specified herein:

Architect – OZ Architecture

Owner – Rocky Vista University Montana

Consultant – D.L. Adams Associates.

Contractor – The Contractor is the firm submitting a proposal to provide final design documents as well as furnish and install the Work as defined within this Specification.

Project – The audio and video systems installation in the facilities of the Rocky Vista University.

Work – The term “Work” means all construction and services specified within this document. The Work includes all related labor, materials, equipment, and services provided, or to be provided, by the Systems Contractor to fulfill the proposal’s obligations.

Drawings – The term “Drawings” means all Audio-Video Systems Drawings and associated sketches, details, etc.

As used in the Drawings and Specifications for the Work, certain non-technical words and phrases shall be understood to have specific meanings as follows, regardless of indications to the contrary in the General Conditions or other documents governing the Work.

“Furnish” – Purchase and deliver to the project site complete with every necessary appurtenance and support, all as part of the Audiovisual Systems Work. Purchasing shall include payment of all sales taxes and other surcharges as may be required to assure that purchased items are free of all liens, claims, or encumbrances.

“Install” – Unload at the delivery point at the site and perform every operation necessary to establish secure mounting and correct operation at the proper location in the project, all as part of the Work.

“New” – Manufactured within the past year and never before used.

“Provide” – Furnish and Install.

Regardless of their usage in codes or other industry standards, certain words or phrases as used in the Drawings or Specifications for the Work, shall be understood to have the specific meanings as described to them in the following list:

“Audiovisual Closet” – The enclosed area or room specifically designated for the routing, termination, and/or cross connecting of Audio and Video Systems cable (i.e. riser cable) to other Audio and Video Systems cable and/or equipment.

“AV” – Audiovisual or Audio and Video Systems

“AVC” – Audiovisual Systems Contractor.

“AV System(s)” – Audio and Video System(s), includes all components contained herein that work in conjunction to create and completely integrated and fully functioning system as described within the Drawings and Specifications.

“AV Systems Control Room” and/or “AV Systems Headend” – The enclosed area or room specifically designated for the routing, termination, and/or cross connecting of Audiovisual System cable (i.e. riser cable) to other AV System cable, and/or equipment and racks.

“Circuit” – Any specific run of circuitry.

“Circuitry” – Any Work which consists of wires, cables, raceways, and/or specialty wiring method assemblies complete with associated junction boxes, pull boxes, outlet boxes, joints, couplings, splices, and connections except where limited to a lesser meaning by specific description.

“Concealed” (as applied to circuitry) – Covered completely by building materials, except for penetrations (by boxes and fittings) to a level flush with the surface as necessitated by functional or specified accessibility requirements.

“Exposed” (as applied to circuitry) – Not covered in any way by building materials.

“NIC” – Not in Contract

"Normal Work Conditions" – Locations within building confines that are not damp, wet, or hazardous and that are not used for air handling.

"OFE" – Owner Furnished Equipment

"Patch Panel" – A System of terminal blocks, patch cords, and backboards that facilitate administration of cross-connecting cables.

"Raceway" – Any pipe, duct, extended enclosure, or conduit (as specified for a particular System) which is used to contain wires and which is of such nature as to require that the wires be installed by a "pulling in" procedure.

"Riser" – Shall refer to the portion of the installation that transmits between building floors (or between Audiovisual Systems rooms), also referred to as "Backbone Cabling".

"Standard" (as applied to wiring devices) – Not of a separately designated individual type.

"System" – See "AV Systems"

"Wiring" – see "Circuitry"

Additional Terms:

The term "shall" is mandatory; the term "will" is informative; the term "should" is advisory; and the term "provide" means furnish and install.

Where the word "conduit" is used without specific reference to type, it shall be understood to mean "raceway".

The term "custom" indicates systems or components that shall be designed and fabricated by the Contractor based on the drawings and specifications.

The term "future" indicates systems or components that will be added to the system later but shall be provisioned for now.

The term "equal" indicates systems or equipment that is of the same size, color, design, function, efficiency, etc. as of that specified.

Reference to "U.L. (Materials Construction) Standards" shall mean the "Standards for Safety" published by Underwriters Laboratories, Inc

1.4 SCOPE OF WORK

General:

The intent of this document is to provide Design Build Contractors with enough information to provide a competitive bid to develop a full AV design package and contract documents required for complete working AV systems as described in this document. It shall be the Design Build Contractors responsibility to further develop this design into fully functioning systems that meet all of the requirements of the Owner, Architect, and AV Consultant.

The work as described herein shall be furnished and installed by one firm alone, hereafter referred to as the AV Contractor. The AV Contractor shall furnish and install all equipment, and audio/video signal and control wiring for the AV Systems described herein. The Contractor further agrees that they shall provide all Work as may be required to make a complete and fully functioning system of that which may not be fully defined in these bridging documents.

The specifications and drawings shall be read and used together; system features which are mentioned in one are not necessarily shown in the others. In case of conflict between the drawings and specifications, request clarification. It shall be understood that the Specifications and Drawings

are complementary. Where there are conflicts within the documents, the overall design intent shall govern.

The work provided shall include complete system design and shall be fully operational as shown on audio video system "AV" drawings and described in Paragraph 1.7 herein.

The project documentation is, in general, diagrammatic and/or developed to communicate design intent. The Contractor shall coordinate the installation of all devices and/or equipment with the Owner prior to installation based on the existing field conditions.

The AV Contractor shall coordinate all installed items with associated trades (Electrical, Mechanical, Telecom, etc.) including all necessary cable pass-thrus and structural needs/requirements.

The AV Contractor shall provide all software programming required to provide fully operational systems.

AV Contractor shall conduct a frequency audit of the site prior to selection of wireless operating frequencies. Select frequencies such that systems are free of interference. Coordinate frequencies and specific transmitter/receiver selection using professional wireless audio systems software.

The AV Contractor shall coordinate the specific programming requirements of the AV Control System with a designated Owner representative, including touch screen layouts and page navigation. All programming written for this project shall be the property of the Owner and shall be provided to the Owner upon completion.

Digital video systems in this design shall employ an EDID management strategy and must be HDCP compliant.

Work Included Elsewhere:

Installation of raceway, pull-boxes, plywood backboards and floor-boxes (provided under electrical Work). Coordination is required within the design to verify the appropriate raceways are in place.

Installation and termination of network systems.

Cutting, patching, and painting of walls, unless damaged performing the work described herein.

Coordinated Work:

Coordinate with related trades to schedule the Work and ensure a complete installation in accordance with the schedule outlined by the Owner.

Coordinate all IP device requirements with the data vendor, Owner, and Contractor.

Coordinate all network connectivity requirements with the low voltage cabling contractor and Owner.

It shall be the responsibility of the AV Systems Contractor to provide the cabling contractor with detailed cable installation schedules outlining cabling requirements to all locations.

1.5 GENERAL CONDITIONS

The Contractor represents that they are familiar with and have expertise in the Work of this nature and scope.

The Contractor shall comply with all of the regulations, including safety regulations of national, city, local and other government agencies having jurisdiction concerning the work of the Contractor. The Contractor shall give all notices and comply with all laws, ordinances, codes, rules, and regulations bearing on the conduct of the Work. If the Contractor performs any work, which is contrary to such laws, ordinances, codes, rules and regulations, they shall make all changes for compliance and bear all associated costs.

The Contractor shall be responsible to provide and maintain a storage facility. If this storage facility is required to be on-site it shall be the Contractor's responsibility to coordinate the size and spatial requirements with the Owner. The Contractor shall assume full responsibility for the storage facility and all contents, unless otherwise indicated by the Owner.

The Contractor shall provide all protection necessary to safeguard their work from damage by their operations and the operations of others. Unless the Contractor proves to the Owner's satisfaction that the Work has been damaged by others, the Contractor shall promptly repair, adjust, and clean all defective installations and bear all associated costs.

All of the Contractor's work shall be tested and inspected by all authorities having jurisdiction and in accordance with all Specifications. The Contractor shall coordinate and cooperate fully and shall provide at no additional cost to the Owner, manpower, drawings, facilities, scaffolds, etc. to reasonably assist the inspectors.

The Owner reserves the right to furnish any materials necessary for the Project.

All permits required for any part of the Contractor's work shall be procured and paid for by the Contractor. The Contractor shall determine all permits required and transmit this information to the Owner. If it is determined that the Contractor's work falls reasonably within another party's permit (General Contractor, Electrician, Etc.) the Contractor shall not be required to procure additional permits provided written authorization is provided to the Contractor by the party holding the permit.

The Contractor must state if they intend to utilize a subcontractor and provide said subcontractor's name and address. The subcontractor shall comply with all the same rules, regulations, laws and codes, licenses, etc. as required by the Contractor and as specified herein. The Owner reserves the right to approve or disapprove any subcontractor proposed by Contractor.

The Contractor, upon receiving notice from Owner that the Contractor has furnished inferior, improper or unsound work or materials (including equipment), or work or materials at variance with that which is specified, will, within 24 hours, proceed to remove such work or materials and make good all other work or materials damaged thereby, and, at the option of the Owner, the Contractor shall immediately replace such work or materials with work or materials as specified. The removal, replacement, and repair shall be performed at such times and with manpower sufficient, in the judgment of the Owner, so as to avoid disturbance to occupants, or other ongoing work for the Project.

If the Contractor does not remove such unsound Work within a reasonable time, the Owner may remove it and may store the material at the expense of the Contractor. If the Contractor does not pay the expenses of such removal within ten (10) days' time thereafter, the Owner may, upon written notice, sell such materials at auction or at private sale and shall account for the net proceeds thereof, after deducting all the costs and expenses that should have been borne by the Contractor and all expenses of the sale.

The Owner shall have the authority at all times, until final completion and acceptance of the Work, to inspect and reject work and materials which in its judgment are not in conformity with the Drawings and Details, Room Data Sheets and Specifications, and its decision in regard to character and value of Work shall be final and conclusive on both contracting parties. If the Owner permits said Work or materials to remain, the Owner shall be allowed the difference in value or shall at its election have the right to have said Work or materials repaired or replaced, as well as the damage caused thereby, at the expense of the Contractor, at any time within one (1) year after the completion of the entire project, or within such longer period as may be covered by any guaranty; and neither payments made to the Contractor, nor any other acts of the Owner, shall be construed as evidence of acceptance, waiver, or estoppels.

Any expense incurred by the Owner in connection with the foregoing, shall be borne by the Contractor, and the Owner may withhold money due to the Contractor or recover money already paid to the Contractor, to the extent of such expense.

The Drawings for the Work utilize symbols and schematic diagrams that have no dimensional significance. The Work shall be installed to fulfill the diagrammatic intent expressed on the Drawings, field layouts, and shop drawings of all trades.

Certain details appear on the Drawings for the Work that are specified with regard to the dimensioning and positioning of the Work. These are intended only for general information purposes. They do not obviate field coordination for individual items of the indicated Work.

Information as to general construction and architectural general construction and architectural features and finishes shall be derived from the structural and architectural drawings and specifications and may require ongoing coordination with the Architect and/or Construction Team.

The Work called for under this Contract shall be carried on simultaneously with the Work of other trades and Owner functions in such a manner as to not delay the overall progress of the construction project. The Contractor is responsible for all coordination of the Work with other trades.

Include in the Work all necessary supervision and issuing of all coordination information to any other trades who are supplying work to accommodate the Audiovisual Systems installation. For items of equipment which are to be installed but not purchased as part of the Work, the Work shall include:

Coordination of delivery

Unloading from delivery trucks

Safe handling and field storage up to the time of permanent placement in the project

Correction of any damage to the item(s) caused by the Contractor

Mounting in place and connection(s) as specified

Items which are to be installed, but not purchased as part of the Work shall be carefully examined upon delivery to the project. Claims that any of these items have been received in such condition that their installation will require procedures beyond the reasonable scope of the Work will be considered only if presented in writing within one (1) week of the date of delivery to the project of the items in question. The Work includes all procedures necessary to put in satisfactory operation all items for which no claims have been submitted as outlined above.

1.6 SUMMARY

AV Executive Summary:

This specification provides performance audio and video systems as part of the new Rocky Vista University Medical School of Osteopathic Medicine in Billings Montana.

The project encompasses the audio and video systems within the facilities. These systems are intended to satisfy multiple operational requirements which are detailed in paragraph 1.7.

The AV systems are intended to provide high quality AV capabilities required for presentations, recording, learning, collaboration and critical listening.

All spaces included in the AV systems will receive electrical infrastructure (cable pathways, junction boxes, etc.) to allow them to be upgraded with future technologies without substantial reconstruction.

Applicable Room Types:

Large Classroom

Seminar Room

Pre-function and Lobby

Board Room

Large Conference Room

Medium Conference Room

Small Conference Room

Study Room

Large Study Room

Student Lounge

Large Debrief

Debrief

Anatomy lab

OMM Lab

Flex Classroom

Master Classroom

VR Lab

Harvey Lab

Fitness

Yoga

1.7 SYSTEM DESCRIPTIONS AND FUNCTIONS

Large Classroom: Typical of (2)

Functionality:

The Large Classroom AV systems will be flexible and designed for high quality audio reinforcement with multiple HD video displays for lectures and presentations. The presentations will be typically in the round from the center of the classroom with projection on the classroom soffits with individual displays at each workspace around the perimeter of the room. The system should allow for additional room configurations as required. The classrooms will be supported and controlled from the centralized control room.

Systems:

The systems should consist of but not be limited to the following:

Audio:

Wired microphone connections and a consumer input with Bluetooth will be provided at the presentation wall. Microphone inputs and a consumer input with Bluetooth will also be located at the center lectern location through a patchable floor box.

Sound reinforcement will be provided by main loudspeakers mounted in a ring above the center podium position to reinforce a center instructor/ presenter and a second set of main loudspeakers should be provided at the presentation end of the room for end presentations.

Additional distributed ceiling mounted loudspeakers will be provided around the perimeter of the room for coverage and fill.

An instructor wireless lapel shall be provided for instructor amplification. The wireless lapel should have a rechargeable battery and charging base for charging between classes.

Eight (8) tabletop wireless microphones shall be provided for class discussion/participation. All wireless microphones will be provided with rechargeable battery and charging base for charging between classes.

Twenty (20) wireless discussion system stations (1 per table) with a speaker and microphone will be provided. One (1) wireless chairman station will be for instructor/presenter control. A summed audio output from the discussion system will be provided to the main reinforcement systems and the distributed loudspeaker system for additional audio reinforcement.

Amplifiers, main control, wireless microphone receivers, and all other headend equipment will be located in the control room equipment racks.

Audio recording will be provided by the Owner, AV Contractor shall provide a separate recording output form the main DSP to Owner for Owner provided and installed recording system.

An ADA compliant Assistive Listening System (ALS) will be provided with a discrete send from the system DSP to allow for individual limiting, automatic gain control, and equalization. ALS system shall be provided with the required quantity of receivers, headsets, and neck loops to meet ADA.

Video:

The video system will provide the ability to route both presenter video and individual workstation video to any or all displays simultaneously.

Four (4) HD video projectors will be mounted in a center cluster to project on projection screens mounted in the soffits. The HD video projectors should be capable of horizontal lens shift and digital keystone. The projector shall have a minimum WUXGA resolution and a minimum brightness of 16,000 ANSI lumens.

16:10 widescreen fixed video projection screens will be provided and installed by the AV Contractor on the soffit. The screens will have an approximate viewable area of 150”x 240”. AV Contractor will coordinate exact size based upon final classroom design.

Confirm projector and screen aspect ratios with Owner.

Fifteen (15) video displays will be wall mounted as shown on the AV drawings for individual stations Each display location will have a large backbox to house the decoder, data connections, and power. Each display will have the capability to display both local computer/laptops or duplicate what is been presented on the projection screens. All displays should be rated for 16hrs per day 7 days per week and meet 4K standards.

Video inputs will be located in a patchable floor box at the center of each classroom and each of five (5) central workstations for presentations, wall plates located at each workstation for local inputs, and an additional wall plate input at the front of the room for alternate room set-up. The inputs shall support HDMI and USB-C. An additional input will be provided in the control room.

The video distribution should be based on a network digital distribution system that will support 4K video resolution. The system should be HDCP compliant and allow for EDID management.

Three (3) cameras will be located to provide the ability to record presentations regardless of the room set-up. The cameras will be connected to a camera controller and Owner furnished recorder.

Control:

A control system shall provide a user with the ability to control the AV systems including powering the system on/off, audio control, and video source selection and routing.

Touch screen control panels will be located in the control room as well as in each lectern in the classrooms. Basic presentation presets shall be programmed into the system, allowing a user the ability to easily power the systems on/off, start a video presentation, and adjust audio volumes of microphones and playback devices associated with each classroom.

The control system should be password protected with different levels of user logins relating to the basic presentation system, standard system, and an advanced login. Passwords and login levels will be coordinated with the Owner.

Upon login the user will choose the configuration of the system (in the round or end presentation) from the control room touch panel. This selection should then only display controls associated with that system configuration.

The system should provide true feedback for all devices that offer bidirectional communication, including but not limited to displays and projectors, switchers, recorders, and DSP. It is essential that all control panels reflect current device status of all equipment capable of bidirectional communication.

Visual feedback on control panels showing ranges should be scaled to reflect the actual applicable range. For instance, a volume bar should be scaled such that the bottom of the visual range corresponds with the point at which the audio ceases to be heard.

All supporting devices should be powered off or placed in standby mode on system shut down, including but not limited to displays, projectors, and amplifiers. Power sequencers and controllable power distribution should be utilized where available to power off devices that cannot be placed into a standby mode.

On system start-up, the system should recall a default state to reset audio levels, routing conditions and other functions requested by the Owner.

All control system layouts and functions must be coordinated with Owner before a final control system will be accepted. AV Contractor must make adjustments to control system according to Owner feedback after the system has been in use for no less than 2 months.

Support Equipment:

Equipment racks will be located in the attached control room.

Power sequencing/surge protection and uninterruptible power supplies should be provided for control processor and DSP.

The AV Lectern will be provided by the Owner or furniture provider. AV contractor shall coordinate requirements and cutouts with Owner or furniture provider. All cabling between the floor box connections and the lectern shall be bundled neatly and provided in a cable management armor, such as Techflex or equivalent.

Seminar Room: Typical of (4)

Functionality:

The seminar room will be capable of being combined with the adjacent room and provide discreet or combined audio and video. Each individual room will have video projection, audio support, input plate for presenter at Owner furnished lectern, and user control panel. When the rooms are combined the projectors shall display the same source and audio reinforcement will be combined.

Systems:

The systems should consist of but not be limited to the following:

Audio:

Wired microphone connection and a consumer input with Bluetooth will be provided at the lectern through a wall plate. Each pair of seminar rooms will include an additional wall plate with microphone input at the center of the combined room.

Sound reinforcement will be provided by distributed ceiling mounted loudspeakers. Loudspeakers in both rooms will be combined when rooms are combined.

An instructor wireless lapel shall be provided for instructor amplification. The wireless lapel will have a rechargeable battery and charging base for charging between classes.

Amplifier, DSP, and other headend equipment will be provided in the shared seminar room equipment racks.

Video:

The video system for each seminar room shall have individual video presentation systems that can be merged when combined with the adjacent room.

Video inputs will be located at the lectern for presentations. The inputs will support HDMI and USB-C.

HD video projectors will be ceiling mounted in each room. The projector will have a minimum WUXGA resolution and a minimum brightness of 5,200 ANSI lumens.

16:10 widescreen electric video projection screens will be provided and installed by the AV Contractor. The screens will have an approximate viewable area of 65”x 104”. AV Contractor will coordinate exact size based upon final room design.

Confirm projector and screen aspect ratios with Owner.

Control:

A control system should provide a user with the ability to control the AV systems including powering the system on/off, audio control, and video source selection and routing.

A touch screen control panel should be located in the lectern or wall mounted. Basic presentation presets shall be programmed into the system, allowing a user the ability to easily power the systems on/off, combine rooms, start a video presentation, and adjust audio volumes of microphones and playback devices.

The control system should be password protected with different levels of user logins relating to the basic presentation system, standard system, and an advanced login. Passwords and login levels will be coordinated with the Owner. Upon login the user can choose the

configuration (combined or separate) of the system. This selection will then only display controls associated with that system configuration.

Visual feedback on control panels showing ranges should be scaled to reflect the actual applicable range. For instance, a volume bar should be scaled such that the bottom of the visual range corresponds with the point at which the audio ceases to be heard.

On system start-up, the system shall recall a default state to reset audio levels, routing conditions and other functions requested by the Owner.

All control system layouts and functions must be coordinated with Owner before a final control system will be accepted. AV Contractor must make adjustments to control system according to Owner feedback after the system has been in use for no less than 2 months.

Support Equipment:

Headend equipment, video switchers, DSP, amplifier, and all other support equipment will be provided in a wall mounted equipment rack. The equipment rack will be located in the adjacent storage room. One rack will support two adjacent rooms.

The AV Lectern will be provided by the Owner or furniture provider. AV contractor shall coordinate requirements and cutouts with owner or furniture provider. All cabling between the wall plate connections and the lectern shall be bundled neatly and provided in a cable management armor, such as Techflex or equivalent.

Pre-function and Lobby

Functionality:

The pre-function and lobby will support digital signage.

Systems:

The systems should consist of but not be limited to the following.

Video:

Pre-function will have two (2) 43” digital signage displays mounted adjacent to the large classroom entrances. Digital signage content and signage distribution will be provided by the Owner.

The main entrance lobby will have 55” digital signage displays as shown on drawings. Digital signage content and signage distribution will be provided by the Owner.

Board Room:

Functionality:

The board room AV systems will provide high quality audio and video playback to support meetings and conferencing.

Systems:

The systems should consist of but not be limited to the following:

Audio:

Wall mounted loudspeakers will provide program playback to the board room. Distributed overhead loudspeakers will provide fill for all audio content to the board room. Audio conferencing will be provided by the Owner.

Video:

The video system for the board room will be supported by two (2) 75” wall mounted displays. The displays shall have a large backbox to house the video devices, data connections, and power. Each display will have the capability to display both local computer/laptops and Owner furnished video conferencing. All displays should be rated for 16hrs per day 7 days per week and meet 4K standards.

Video inputs will be provided at the table through two (2) pass-thru floor boxes to table boxes. The inputs should support HDMI and USB-C. Two inputs will be provided at each location (one dedicated to each display)

Control:

A control system shall provide a user with the ability to control the AV systems including powering the system on/off, audio control, and video source selection and routing.

A touch screen control panel should be located at the table start a video presentation and adjust audio volumes of microphones and playback devices.

Visual feedback on control panels showing ranges should be scaled to reflect the actual applicable range. For instance, a volume bar should be scaled such that the bottom of the visual range corresponds with the point at which the audio ceases to be heard.

On system start-up, the system should recall a default state to reset audio levels, routing conditions and other functions requested by the Owner.

All control system layouts and functions must be coordinated with Owner before a final control system will be accepted. AV Contractor must make adjustments to control system according to Owner feedback after the system has been in use for no less than 2 months.

<u>Large Conference Room:</u>

Functionality:

The large conference room AV systems will provide high quality audio and video playback to support meetings and conferencing.

Systems:

The systems should consist of but not be limited to the following:

Audio:

Wall mounted loudspeakers will provide program playback to the large conference room. Distributed overhead loudspeakers will provide fill for all audio content to the conference room. Audio conferencing will be provided by the Owner.

Video:

The video system for the large conference room will be supported by two (2) 75” wall mounted displays. The displays shall have a large backbox to house the video devices, data connections, and power. Each display should have the capability to display both local computer/laptops and Owner furnished video conferencing. All displays should be rated for 16hrs per day 7 days per week and meet 4K standards.

Video inputs will be provided at the table through two (2) pass-thru floor boxes to table boxes. The inputs should support HDMI and USB-C. Two inputs will be provided at each location (one dedicated to each display)

Control:

A control system shall provide a user with the ability to control the AV systems including powering the system on/off, audio control, and video source selection and routing.

A touch screen control panel should be located at the table start a video presentation and adjust audio volumes of microphones and playback devices.

Visual feedback on control panels showing ranges should be scaled to reflect the actual applicable range. For instance, a volume bar should be scaled such that the bottom of the visual range corresponds with the point at which the audio ceases to be heard.

On system start-up, the system should recall a default state to reset audio levels, routing conditions and other functions requested by the Owner.

All control system layouts and functions must be coordinated with Owner before a final control system will be accepted. AV Contractor must make adjustments to control system according to Owner feedback after the system has been in use for no less than 2 months.

Medium Conference Room: Typical of (6)

Functionality:

The medium conference room AV system will provide audio and video connections from the table to wall mounted display.

Systems:

The systems should consist of but not be limited to the following:

Audio:

Audio support will be through the display audio.

Video:

The video system for the medium conference room will be supported by one (1) 65” wall mounted display. The display shall have a large backbox to house the video devices, data connections, and power. The display should have the capability to display a local computer or laptop. The display should be rated for 16hrs per day 7 days per week and meet 4K standards.

A video input should be provided at the table through a pass-thru floor box to a table box. The inputs will support HDMI and USB-C.

Control:

Display control will be provided by the display remote control.

Small Conference Room: Typical of (2)

Functionality:

The small conference room AV system will provide audio and video connections from the table to wall mounted display.

Systems:

The systems should consist of but not be limited to the following:

Audio:

Audio support will be through the display audio.

Video:

The video system for the small conference room will be supported by one (1) 55” wall mounted display. The display shall have a large backbox to house the video devices, data connections, and power. The display should have the capability to display a local computer or laptop. The display should be rated for 16hrs per day 7 days per week and meet 4K standards.

A video input should be provided at the table through a pass-thru floor box to a table box. The inputs will support HDMI and USB-C.

Control:

Display control will be provided by the display remote control.

Small Study Room: Typical of (31)

Functionality:

The small study room AV system will provide audio and video connections from an adjacent wall plate to the wall mounted display.

Systems:

The systems should consist of but not be limited to the following.

Audio:

Audio support will be through the display audio.

Video:

The video system for the small study room will be supported by one (1) 55” wall mounted display. The display shall have a large backbox to house the video devices, data connections, and power. The display should have the capability to display a local computer or laptop. The display should be rated for 16hrs per day 7 days per week.

A video input will be provided wall mounted above table height below the display. The inputs shall support HDMI and USB-C.

Control:

Display control will be provided by the display remote control.

Large Study Room: Typical of (9)

Functionality:

The Large Study Room AV system will provide audio and video connections from the table to wall mounted display.

Systems:

The systems should consist of but not be limited to the following:

Audio:

Audio support will be through the display audio.

Video:

The video system for the large conference room will be supported by one (1) 65” wall mounted display. The display shall have a large backbox to house the video devices, data connections, and power. The display will have the capability to display a local computer or laptop. The display should be rated for 16hrs per day 7 days per week.

A video input will be provided at the table through a pass-thru floor box to a table box. The inputs will support HDMI and USB-C.

Control:

Display control will be provided by the display remote control.

Student Lounge and Rec Center

Functionality:

Provide a digital signage display and an additional display for connection of user provided devices, such as gaming systems or laptop computers. Audio connections will be provided to play background music for both the lounge and the rec center.

Systems:

The systems should consist of but not be limited to the following.

Audio:

Wall mounted consumer audio interface with Bluetooth audio will be supplied for connection of and portable audio devices.

Ceiling mounted speakers zoned for the Lounge and Rec Center.

Amplifier and processing equipment will be located in the cabinet below the consumer audio interface.

Video:

One (1) 55” digital signage display shall be wall mounted near the main entrance. Digital signage content and signage distribution will be provided by the Owner.

One (1) 55” wall mounted display will be provided in the student rec center. The display shall have a large backbox to house the video devices, data connections, and power. The display should have the capability to display video sources from the local input or other Owner provided source, such as a Roku player.

A wall mounted video input should be provided located below display. The inputs will support HDMI connections.

Control:

Background music levels will be controlled by wall mounted volume controls in Lounge and Rec Center.

Display control will be provided by the display remote control.

Large Debrief

Functionality:

The large Debrief Room will have video projection, audio support, input plate for presenter at Owner furnished lectern, and user control panel.

Systems:

The systems should consist of but not be limited to the following:

Audio:

Wired microphone connection and a consumer input with Bluetooth will be provided at the lectern.

Sound reinforcement will be provided by distributed ceiling mounted loudspeakers.

A wireless lapel microphone shall be provided for instructor amplification. The wireless lapel should have a rechargeable battery and charging base for charging between classes.

Amplifier, DSP, and other headend equipment will be provided in the lectern.

Video:

Video inputs will be located at the lectern for presentations. The inputs should support HDMI and USB-C.

Two (2) HD video projectors will be ceiling mounted. The projector shall have a minimum WUXGA resolution and a minimum brightness of 5,200 ANSI lumens. Both projectors will display the same image

Two (2) 16:10 widescreen electric video projection screens will be provided and installed by the AV Contractor. The screens should have an approximate viewable area of 65”x 104”. AV Contractor will coordinate exact size based upon final room design.

Confirm projector and screen aspect ratios with Owner.

Control:

A control system shall provide a user with the ability to control the AV systems including powering the system on/off, audio control, and video source selection and routing.

A touch screen control panel should be located in the lectern. Basic presentation presets will be programmed into the system, allowing a user the ability to easily power the systems on/off and adjust audio volumes of microphones and playback devices.

Visual feedback on control panels showing ranges should be scaled to reflect the actual applicable range. For instance, a volume bar should be scaled such that the bottom of the visual range corresponds with the point at which the audio ceases to be heard.

On system start-up, the system shall recall a default state to reset audio levels, routing conditions and other functions requested by the Owner.

All control system layouts and functions must be coordinated with Owner before a final control system will be accepted. AV Contractor must make adjustments to control system according to Owner feedback after the system has been in use for no less than 2 months.

Support Equipment:

The AV Lectern will be provided by the Owner or furniture provider. AV contractor will coordinate requirements and cutouts with owner or furniture provider. All cabling between the wall plate connections and the lectern shall be bundled neatly and provided in a cable management armor, such as Techflex or equivalent.

Debrief Typical of (2)

Functionality:

The Debrief room will provide video presentation and audio support with inputs and user control for presenter at the Owner furnished lectern.

Systems:

The systems should consist of but not be limited to the following:

Audio:

Wired microphone connection and a consumer input with Bluetooth will be provided at the lectern.

Sound reinforcement will be provided by distributed ceiling mounted loudspeakers.

A wireless lapel microphone shall be provided for instructor amplification. The wireless microphone should have a rechargeable battery and charging base for charging between classes.

Amplifier, DSP, and other headend equipment will be provided in the lectern rack.

Video:

Video inputs will be located at the lectern for presentations. The inputs should support HDMI and USB-C.

HD video projectors will be ceiling mounted in each room. The projector will have a minimum WUXGA resolution and a minimum brightness of 5,200 ANSI lumens.

16:10 widescreen electric video projection screens will be provided and installed by the AV Contractor. The screens should have an approximate viewable area of 65”x 104”. AV Contractor will coordinate exact size based upon final room design.

Confirm projector and screen aspect ratios with Owner.

Control:

A control system shall provide a user with the ability to control the AV systems including powering the system on/off, audio control, and video source selection and routing.

A touch screen control panel should be located in the lectern. Basic presentation presets will be programmed into the system, allowing a user the ability to easily power the systems on/off and adjust audio volumes of microphones and playback devices.

Visual feedback on control panels showing ranges should be scaled to reflect the actual applicable range. For instance, a volume bar should be scaled such that the bottom of the visual range corresponds with the point at which the audio ceases to be heard.

On system start-up, the system shall recall a default state to reset audio levels, routing conditions and other functions requested by the Owner.

All control system layouts and functions must be coordinated with Owner before a final control system will be accepted. AV Contractor must make adjustments to control system according to Owner feedback after the system has been in use for no less than 2 months.

Support Equipment:

The AV Lectern will be provided by the Owner or furniture provider. AV contractor shall coordinate requirements and cutouts with owner or furniture provider. All cabling between the wall plate connections and the lectern shall be bundled neatly and provided in a cable management armor, such as Techflex or equivalent.

Anatomy Lab

Functionality:

The Anatomy Lab will provide video presentation and audio support with inputs and user control for presenter at the Owner furnished lectern. The lab will support the main video projector as well as distributed ceiling mounted displays.

Systems:

The systems should consist of but not be limited to the following:

Audio:

Wired microphone connection and a consumer input with Bluetooth will be provided at the lectern.

Sound reinforcement shall be provided by distributed ceiling mounted loudspeakers.

A wireless lapel microphone shall be provided for instructor amplification. The wireless microphone should have a rechargeable battery and charging base for charging between classes.

Amplifier, DSP, and other headend equipment will be provided in the lectern rack.

Video:

Video inputs will be located at the lectern for presentations. The inputs should support HDMI and USB-C.

A HD video projector will be ceiling mounted. The projector shall have a minimum WUXGA resolution and a minimum brightness of 8,000 ANSI lumens.

16:10 widescreen electric video projection screen will be provided and installed by the AV Contractor. The screen should have an approximate viewable area of 87½"x140”. AV Contractor shall coordinate exact size based upon final room design.

Confirm projector and screen aspect ratios with Owner.

Eight (8) ceiling mounted displays will be provided throughout the anatomy lab to provide direct viewing from the student work stations. The displays should be rated for 16hrs per day 7 days per week and meet 4K and DICOM standards.

Projector and distributed displays will allow for independent video source selection allowing for the same or independent sources for the distributed displays and the projector. All distributed displays will receive the same source.

A straight down fixed ceiling camera will be provided above the teacher's work stations. The camera will have a zoom and be capable of low light video capture.

Control:

A control system shall provide a user with the ability to control the AV systems including powering the system on/off, audio control, and video source selection and routing.

A touch screen control panel should be located in the lectern. Basic presentation presets shall be programmed into the system, allowing a user the ability to easily power the systems on/off and adjust audio volumes of microphones and playback devices.

Visual feedback on control panels showing ranges should be scaled to reflect the actual applicable range. For instance, a volume bar should be scaled such that the bottom of the visual range corresponds with the point at which the audio ceases to be heard.

On system start-up, the system shall recall a default state to reset audio levels, routing conditions and other functions requested by the Owner.

All control system layouts and functions must be coordinated with Owner before a final control system will be accepted. AV Contractor must make adjustments to control system according to Owner feedback after the system has been in use for no less than 2 months.

Support Equipment:

The AV lectern will be provided by the Owner or furniture provider. AV contractor will coordinate requirements and cutouts with owner or furniture provider. All cabling between the wall plate connections and the lectern shall be bundled neatly and provided in a cable management armor, such as Techflex or equivalent.

OMM Lab

Functionality:

The OMM lab will provide video presentation and audio support with inputs and user control for presenter at the Owner furnished lectern. The lab will support the main video projector as well as distributed ceiling mounted displays throughout the lab.

Systems:

The systems should consist of but not be limited to the following:

Audio:

Wired microphone connection and a consumer input with Bluetooth will be provided at the lectern.

Sound reinforcement shall be provided by distributed ceiling mounted loudspeakers.

An instructor wireless lapel microphone shall be provided for instructor amplification. The wireless microphone should have a rechargeable battery and charging base for charging between classes.

5 additional wireless lapel microphones will be provided for additional instructors. The wireless microphone should have a rechargeable battery and charging base for charging between classes.

Amplifier, DSP, and other headend equipment will be provided in the lectern rack.

Video:

Video inputs will be located at the lectern for presentations. The inputs should support HDMI and USB-C.

A HD video projector will be ceiling mounted. The projector shall have a minimum WUXGA resolution and a minimum brightness of 8,000 ANSI lumens.

16:10 widescreen electric video projection screen will be provided and installed by the AV Contractor. The screen should have an approximate viewable area of 87½"x140". AV Contractor shall coordinate exact size based upon final room design.

Confirm projector and screen aspect ratios with Owner.

Sixteen (16) ceiling mounted displays shall be provided throughout the anatomy lab to provide direct viewing from the student work stations. The displays should be rated for 16hrs per day 7 days per week and meet 4K standards.

Projector and distributed displays should allow for independent video source selection allowing for the same or independent sources for the distributed displays and the projector. All distributed displays will receive the same source.

A straight down fixed ceiling camera will be provided above the teacher's work stations. The camera should have a minimum 20X zoom and be capable of low light video capture.

A center ceiling mounted PTZ camera shall be provided and include joystick control from the AV lectern. PTZ camera should have a minimum 20X zoom and be capable of low light video capture.

Control:

A control system shall provide a user with the ability to control the AV systems including powering the system on/off, audio control, and video source selection and routing.

A touch screen control panel will be located in the lectern. Basic presentation presets shall be programmed into the system, allowing a user the ability to easily power the systems on/off and adjust audio volumes of microphones and playback devices.

Visual feedback on control panels showing ranges should be scaled to reflect the actual applicable range. For instance, a volume bar should be scaled such that the bottom of the visual range corresponds with the point at which the audio ceases to be heard.

On system start-up, the system shall recall a default state to reset audio levels, routing conditions and other functions requested by the Owner.

All control system layouts and functions must be coordinated with Owner before a final control system will be accepted. AV Contractor must make adjustments to control system according to Owner feedback after the system has been in use for no less than 2 months.

Support Equipment:

The AV Lectern will be provided by the Owner or furniture provider. AV contractor will coordinate requirements and cutouts with owner or furniture provider. All cabling between the wall plate connections and the lectern shall be bundled neatly and provided in a cable management armor, such as Techflex or equivalent.

Flex Classroom

Functionality:

The flex classroom will provide video presentation and audio support with inputs and user control for presenter at the flex classroom workstation. Video presentation will be provided by a video projector and screen.

Systems:

The systems should consist of but not be limited to the following:

Audio:

Wired microphone connection and a consumer input with Bluetooth will be provided at the teacher workstation.

Sound reinforcement shall be provided by distributed ceiling mounted loudspeakers.

A wireless lapel microphone shall be provided for instructor amplification. The wireless microphone should have a rechargeable battery and charging base for charging between classes.

Amplifier, DSP, and other headend equipment will be provided in the lectern rack.

Video:

Video inputs will be located at the lectern for presentations. The inputs should support HDMI and USB-C.

An HD video projector will be ceiling mounted. The projector shall have a minimum WUXGA resolution and a minimum brightness of 8,000 ANSI lumens.

16:10 widescreen electric video projection screen will be provided and installed by the AV Contractor. The screen should have an approximate viewable area of 87½"x140". AV Contractor shall coordinate exact size based upon final room design.

Confirm projector and screen aspect ratios with Owner.

A center ceiling mounted PTZ camera shall be provided and include joystick control from the workstation. PTZ camera should have a minimum 20X zoom and be capable of low light video capture.

Control:

A control system shall provide a user with the ability to control the AV systems Including powering the system on/off, audio control, and video source selection and routing.

A touch screen control panel should be located in the lectern. Basic presentation presets shall be programmed into the system, allowing a user the ability to easily power the systems on/off and adjust audio volumes of microphones and playback devices.

Visual feedback on control panels showing ranges should be scaled to reflect the actual applicable range. For instance, a volume bar should be scaled such that the bottom of the visual range corresponds with the point at which the audio ceases to be heard.

On system start-up, the system shall recall a default state to reset audio levels, routing conditions and other functions requested by the Owner.

All control system layouts and functions must be coordinated with Owner before a final control system will be accepted. AV Contractor must make adjustments to control system according to Owner feedback after the system has been in use for no less than 2 months.

Support Equipment:

The workstation, including AV rack elements, will be provided by the Owner or furniture provider. AV contractor will coordinate requirements and cutouts with owner or furniture provider.

Master Classroom

Functionality:

The Master Classroom AV systems will be designed for high quality audio reinforcement with HD video projection for lectures and presentations. Video inputs shall be located at the Master Classroom podium. Sound reinforcement shall be provided by ceiling mounted loudspeakers.

Systems:

The systems should consist of but not be limited to the following.

Audio:

Consumer input and Bluetooth input will be provided at the lectern.

Sound reinforcement will be provided by distributed ceiling mounted loudspeakers.

An instructor wireless lapel shall be provided for instructor amplification. The wireless lapel should have a rechargeable battery and charging base for charging between classes.

Eight (8) tabletop wireless microphones shall be provided for class discussion/participation. All wireless microphones should be provided with rechargeable battery and charging base for charging between classes.

Video:

An HD video projector shall be ceiling mounted. The HD video projector must be capable of horizontal lens shift and digital keystone. The projector shall have a minimum WUXGA resolution and a minimum brightness of 5,200 ANSI lumens.

A 16:10 widescreen video projection screen will be provided and installed by the AV Contractor at the front of the room. The screen will have an approximate viewable area of 65” x 104” and should have a high contrast screen surface. AV Contractor shall coordinate exact size based upon final classroom design.

Confirm projector and screen aspect ratios with Owner.

Video input shall be provided on the classroom lectern for connection of a resident computer, laptop, document camera, or Blu-ray player.

Control:

A control system shall provide a user with the ability to control the AV systems including powering the system on/off, audio control, and video source selection and routing.

A touch screen control panel should be located in the lectern. Basic presentation presets should be programmed into the system, allowing a user the ability to easily power the systems on/off and adjust audio volumes of microphones and playback devices.

Visual feedback on control panels showing ranges should be scaled to reflect the actual applicable range. For instance, a volume bar should be scaled such that the bottom of the visual range corresponds with the point at which the audio ceases to be heard.

On system start-up, the system shall recall a default state to reset audio levels, routing conditions and other functions requested by the Owner.

All control system layouts and functions must be coordinated with Owner before a final control system will be accepted. AV Contractor must make adjustments to control system according to Owner feedback after the system has been in use for no less than 2 months.

Support Equipment:

The lectern, including AV rack elements, will be provided by the Owner or furniture provider. AV contractor will coordinate requirements and cutouts with owner or furniture provider. All cabling between the wall plate connections and the lectern shall be bundled neatly and provided in a cable management armor, such as Techflex or equivalent.

VR Lab

Functionality:

VR lab systems will be provided by the owner, with the exception of one (1) wall mounted display to allow observation of the VR participants.

Systems:

The systems should consist of but not be limited to the following.

Video:

One (1) 55” Display shall be wall mounted. Video source or connection to the VR system will be provided by the owner.

Control:

Display control will be provided by the display remote control.

Harvey Lab Typical of (2)

Functionality:

The Harvey Lab will provide video presentation with inputs for a presenter at the wall plate.

Systems:

The systems should consist of but not be limited to the following:

Video:

Video inputs shall be located at the wall plate for presentations. The inputs should support HDMI and USB-C.

HD video projector shall be ceiling mounted in each room. The projector should have a minimum WUXGA resolution and a minimum brightness of 5,200 ANSI lumens.

16:10 widescreen electric video projection screens will be provided and installed by the AV Contractor. The screens should have an approximate viewable area of 57½” x 92”. AV Contractor shall coordinate exact size based upon final room design.

Confirm projector and screen aspect ratios with Owner.

Fitness

Functionality:

The fitness room AV systems will provide light music playback and distributed video displays.

Systems:

The systems should consist of but not be limited to the following.

Audio:

Wall mounted consumer input and Bluetooth input should be provided above the counter located near the entrance.

Playback will be provided by ceiling mounted loudspeakers.

Video:

55” Displays should be ceiling mounted and located to serve the treadmills and the elliptical machine.

Source device, such as a Roku player, will be provided by the Owner.

Control:

Audio control will be provided by a wall mounted volume control.

Display control will be provided by the display remote control.

Support Equipment:

Headend equipment and amplifier will be provided in a wall mounted m equipment rack. The equipment rack shall be located in the adjacent storage room. This rack will also serve the Yoga room.

Yoga

Functionality:

The Yoga room audio reinforcement system will provide light music playback and instructor amplification to the Yoga room.

Systems:

The systems should consist of but not be limited to the following.

Audio:

Wall mounted consumer input and Bluetooth input will be provided located at the rear counter.

One (1) Channel of wireless microphone with an on-ear microphone element.

Playback will be provided by ceiling mounted loudspeakers.

Headend equipment and amplifier will be located in the Fitness Room equipment rack.

Control:

Control should be provided by a wall mounted volume control. Separate volume shall be provided for music and microphone level.

1.8 QUALITY ASSURANCE

AV Contractor's Qualifications:

The work of this section will be contracted to a single firm, referred to as the AV Contractor, for sole responsibility.

The AV Contractor shall be experienced in the installation of professional AV systems and have completed within the past five years at least three AV system projects of a size and scope comparable to the project described herein.

The AV Contractor shall have factory-certified programmers for the programming of any processing and control equipment used in this project. The AV Contractor must have a manufacturer certified programmer on staff for any specialized equipment requiring programming for the duration of this project.

The AV Contractor shall have capabilities and in-house facilities for installation, shop fabrication and repair service of professional AV systems.

The AV Contractor shall have on their full-time payroll at least one staff engineer having five years minimum experience as an audio engineer. In place of a qualified staff engineer, the AV Contractor may retain a consulting engineer to direct the project. Prior to bid acceptance, the qualifications of the consulting engineer shall be submitted for the approval of the Consultant. Said staff or consulting engineer shall:

Provide all technical liaisons between the AV Contractor and the Consultant.

Represent the AV Contractor at meetings and conferences and be present at the job site for final inspection.

Be responsible for supervision of all technical and engineering work required executing the contract, approving, and signing the shop drawings.

Qualification of Contractors:

Bids submitted by Contractors who have not been Qualified will not be accepted.

Minimum Performance Requirements:

To meet the minimum performance requirements, the AV Contractor shall be responsible for:

Each component's conformance with the manufacturer's published specifications and other requirements as stated herein.

Detailed checking of each item of equipment provided each portion of the installation, and of the complete installation to find and remedy any defects therein.

Setting the system gain structure, including initial adjustment of digital signal processing, and amplifier gain controls and, under the direction of the Consultant, making the final adjustment of these items and, if so directed, resetting loudspeaker levels and providing additional field-assembled resistive pads and/or resistor-capacitor equalizers.

Alignment and focus of video projectors and adjusting for optimized settings. Under the direction of the Consultant, if required, making final adjustments to the projector and associated video processing equipment.

Adjusting/applying EDID management strategy and adjusting color space for all displays in order to display the most optimal image possible for each video source.

Applicable Standards and Codes:

In addition to all applicable local and state codes, the work shall be in accordance with the latest revisions of all applicable standards and specifications of the following:

NAB - National Association of Broadcasters

UL - Underwriters Laboratories

EIA - Electrical Industries Association

NEC - National Electrical Code

Final Acceptance:

Final acceptance shall be contingent upon issuance by the Owner of a letter of acceptance stating that the work has been completed and is in accordance with the contract documents.

Manufacturers' Qualifications:

All electronic products shall be designed and marketed by the manufacturer for application in professional video projection, sound amplifying, reproduction and recording systems.

All products proposed by the AV Contractor for use in the systems described herein are subject to approval by the Owner.

1.9 SUBMITTALS

Contractors shall submit for approval, brochures bound in flexible binders containing a statement of the AV Contractor's qualifications. As a minimum, this submittal shall include the following:

A list of AV systems of comparable size and scope to that described herein, completed by the AV Contractor in the last five (5) years. Show project name and address, year of completion and the name and telephone number of a person to contact who is a representative of the Owner or User.

A personal resume of formal education and experience of the qualified staff engineer who would direct the work.

A personal resume of the staff member(s) with the required manufacturer certification and control system programming qualifications.

A description of the AV Contractor's capabilities and facilities for rack assembly, shop fabrication, software programming, repair, and servicing of AV systems.

A letter from the processor and control system manufacturer(s) certifying that the AV Contractor’s software programmers have been factory trained and are qualified to provide the proposed installation.

PART 2 - PRODUCTS

2.0 MATERIALS

All materials, equipment and apparatus shall be new and of the latest design or model offered for sale by the manufacturer.

Principal items of equipment and apparatus are identified herein by manufacturer. Alternate manufacturers are identified in instances in which equivalence has been determined.

For all items which are identified by part number and manufacturer, performance specifications which are published in the most recent manufacturer's data sheets available at the time of bidding this contract shall be applicable to the present work as though fully written out herein.

For those items which are not identified, the Design Build Contractor may select items which conform to the functional and/or technical specifications. For all such items, the Contractor shall submit for approval all technical data which is available from the supplier or manufacturer.

2.1 BASIS OF DESIGN FOR EQUIPMENT

All equipment selected by design build contract will be reviewed by Owner for approval. Following equipment is intended as to represent major pieces and are listed for basis of design only.

Video Switching, Routing, and Transport:

Basic Requirements:

Digital Transport

4k Capable

Manufacturers:

Crestron

Approved Equivalent

Control System and Control Interfaces:

Basic Requirements:

Network Based

Capacitive Touch Panels Sized Appropriately

Manufacturers:

Crestron

Extron

Approved Equivalent

Video Projection:

Basic Requirements:

Laser

3-chip DLP For Spaces Requiring Critical Viewing 1-Chip DLP Minimum

Min WUXGA 4k Preferred

Manufacturers:

Panasonic

Barco

Approved Equivalent

Video Projection Screens:

- Basic Requirements:
  - Motorized Tab Tensioned Typ.
  - Fixed Screens for Large Classrooms
  - High Contrast
  - 0.8-0.9 Gain Typical
- Manufacturers:
  - Draper
  - Da-Lite
  - Approved Equivalent

Displays:

- Basic Requirements:
  - 4k UHD Resolution
  - 16/7 Min Operation
- Manufacturers:
  - Panasonic SQ Series
  - Approved Equivalent

Cameras:

- Basic Requirements:
  - 4k/60p
  - PTZ
  - IP Control
  - POE Power
- Manufacturers:
  - Panasonic
  - PTZ optics
  - Approved Equivalent

Audio Signal Processing:

- Basic Requirements:
  - Integrated Core Processor
  - Flexible I/O

Support Analog, Digital, and Network Audio

Manufacturers:

QSC

Biamp

Approved Equivalent

Amplifiers:

Basic Requirements:

Standby mode or power sequencing

Sized to meet maximum loudspeaker rating plus min 15% headroom

Manufacturers:

QSC

Crown

Approved Equivalent

Wireless Microphones:

Basic Requirements:

Rechargeable with docking charging station

Manufacturers:

Shure MXW

Approved Equivalent

Ceiling Mounted Loudspeakers:

Basic Requirements:

6.5” two-way

Integral Back Can

Manufacturers:

EV Evid C6.2

JBL Control 26C/T

QSC ADC6T

Approved Equivalent

Presentation Speakers (Large Classrooms, Large Conference Room, Board Room):

Basic Requirements:

Minimum 8” two way

Min 10” for larger spaces

Manufacturers:

EAW JF series

Martin Audio CDD Series

Fulcrum Audio CCX series

Approved Equivalent

Discussion Systems:

Basic Requirements:

Wireless

Master Station

Charging Station

One Chairperson station per space

Manufacturers:

Televic

Approved Equivalent

Consumer Input with Bluetooth:

Basic Requirements:

Remotely powered

Customizable Bluetooth Naming

Manufacturers:

RDL

Attero Tech

Approved Equivalent

2.2 EQUIPMENT

Any and all equipment must be submitted for approval. It is the responsibility of the Design Build Contractor to ensure that submitted equipment is compatible with the overall system design, intent, and electrical infrastructure. All equipment is subject to review and approval by the Consultant.

2.3 EQUIPMENT PERFORMANCE SPECIFICATIONS

The performance specifications for all components shall be as published in the most recent manufacturer's data sheets available at the time of bidding this contract and shall be applicable to the present work as though fully given herein.

Digital video transmission system cabling (twisted pair and fiber optic) shall be as specified by manufacturer.

Network and control cabling for the control systems shall be as recommended by the manufacturer. If not in conduit then cable must be plenum rated.

PART 3 - EXECUTION

3.0 COORDINATION

The Design Build Contractor shall coordinate this Work with all other relevant trades.

Locations shown on AV Drawings are approximate. Refer to Architectural drawings for dimensions.

3.1 FABRICATION

Design/Engraving:

All equipment controls, receptacles and all indicators shall have, unless otherwise noted, lamacoid, permanently engraved, or silk screened fully descriptive identification labels. The resolution of silk-screened labels shall not be less than 90,000 dots/sq. in.

The word "engraved" shall mean that the identification shall be engraved into the indicated panel, plate, or control surface.

All engraving shall be with 5/32" high characters, unless otherwise noted, and shall be filled with engraver's enamel of a contrasting color.

Receptacle Plates:

Receptacles shall be screwed, bolted or flush-riveted to the plate.

Plates shall be marked to indicate function and circuit of the receptacle, for example: MICROPHONE.

Terminals and Terminations:

Microphone cables shall not be spliced or otherwise interrupted from termination to termination. All cables shall have visible adhesive identifying markers on each end.

Wiring in terminal cabinets shall be tied and clamped neatly to backboards or cableforms.

Terminals shall, unless otherwise specified, be one of the following types:

Wire-wrap type terminal block.

Barrier strips with screw terminals.

Each terminal strip shall have a legibly marked identification strip.

Structural Assemblies:

Provide holes required for securing other components or assemblies to structural steel framing and for passage of other components through steel framing members as shown on final shop drawings. Cut, drill or punch holes perpendicular to metal surfaces. Do not flame cut holes or enlarge holes by burning.

In fabricating mounting brackets and other steel components requiring bends, the radii of the bends shall not be less than three times the thickness of the steel being bent.

All bolts and nuts used in the fabrication of mounting hardware shall be Grade 5 or better.

3.2 INSTALLATION

Supply completely assembled and fully shop-tested racks with all internal wiring completed as required to provide a complete system, to the extent that such items are not provided by others.

Secure equipment firmly in place, including loudspeakers, amplifiers, and cables. Make fastenings and supports adequate to support their loads with a safety factor of five.

Install work neatly, with boxes, equipment, etc. plumb and square. Keep the job adequately staffed at all times. Designate a field supervisor to be present on the job site and in responsible charge during all phases of installation and check out. Maintain same supervisor throughout the execution of the work unless circumstances beyond the control of the Contractor intervene. Install the system in cooperation with other trades in order to achieve coordinated progress and satisfactory final results. Watch for conflicts with work of other trades on the job. Execute without claim for extra payment, moderate moves or changes as are necessary to accommodate other equipment or preserve symmetry and pleasing appearance.

Locate all apparatus requiring adjustments, cleaning, or similar attention so that it will be accessible.

All supporting structures and enclosures supplied by the Contractor, not having a standard factory paint finish, shall be painted. Paint specifications and color shall be supplied by the Architect.

Color and finish of blank panels and custom assembly panels shall match adjacent equipment panels to the extent possible. The finish of wall mounted receptacle panels shall be coordinated with the Architect.

Clearly, logically, and permanently mark switches, connectors, jacks, relays, receptacles, cables and cable terminations.

Etch, engrave, silk screen or apply in a similar permanent manner all legends and markings on all custom panels and receptacle plates. Embossed tape, press type, etc., are not acceptable.

The equipment specified herein must be capable of operation in environments of normal humidity, dust and temperature. The Contractor should avoid installing equipment where extreme environmental conditions can occur and shall be responsible for protection of equipment and related wiring from such conditions.

The Contractor shall take precautions to prevent electromagnetic and electrostatic hum. Install the equipment to provide safe operation. Provide ventilation as required to maintain equipment within the manufacturers specified temperature limits.

Provide all cables necessary for interconnection of permanently mounted equipment. Use terminations required to achieve full function of equipment as specified herein.

Exercise care in wiring, to avoid damage to the cables and to the equipment. Make all joints and connections with rosin-core solder or with mechanical connectors approved for Class I wiring. Execute all wiring in strict adherence to standard broadcast procedures.

Run lines in separate metallic conduits for microphone level circuits (up to -20 dBm), line level circuits (up to +30 dBm), loudspeaker circuits (above +30 dBm) and power circuits. Non-metallic or PVC conduits for AV system wiring are not acceptable. Ground power conduits with heavy wire to the power system ground. Use only cables which are insulated from the conduit and from each other for the entire conduit length. Connect AV system conduits mechanically and electrically to the AV system ground point. Do not splice lines in conduit.

3.3 TESTING

Audio System Tests:

General Inspection and Adjustment: Measure and subsequently document that all individual components are performing in accordance with each manufacturer's published specifications. Specifically, examine frequency response, total harmonic distortion, and signal-to-noise ratio. Replace any components found to be defective.

Loudspeaker Line Impedance: Measure the impedance and the resistance of each loudspeaker line leaving the AV equipment racks with the line disconnected from its normal driving source. Maintain values within +10% of the value calculated for that circuit based upon the parallel impedances of the loudspeakers connected plus the resistance of the loudspeakers. Measure loudspeaker impedance at 250 Hz and 1000 Hz. Measure full-range loudspeaker impedance.

Hum and Noise Level: Measure the hum and noise levels of the overall system. Adjust gain controls for optimum signal-to-noise ratio. The adjustment shall also be such that full amplifier output would be achieved with 0 dBm input. Terminate inputs with shielded resistors of 600 ohms for these measurements. Disconnect the loudspeaker lines and terminate the power amplifier outputs with power resistors for these measurements. The load resistors shall match the rated load impedance and output power of the amplifiers.

Power Output and Signal Level Adjustments: Measure the electrical distortion of the overall system. Adjust gain controls as for the hum and noise level test. Set variable equalizers for flat response. Apply 1,000 Hz sine wave signal at the input tested, at a level required to produce a full amplifier output. Use a distortion analyzer to measure the output level and total harmonic distortion of the amplification equipment. Make all measurements with loads actually incurred in system operation. Power amplifier loads shall be resistors equal to the nominal impedance of the loudspeaker loads used in the system.

Freedom from Parasitic Oscillation and Radio-Frequency Pickup: Check to ensure that the system is free from spurious oscillation and radio-frequency pickup, both in the absence of any audio input signal and also when the system is driven to full output at 100 Hz. Employ an oscilloscope as specified.

Loudspeaker Phasing: Perform phasing checks of loudspeaker lines by means of a DC source at one end of each line and a voltmeter at the other and. Phase all loudspeaker lines identically with respect to color coding.

Freedom from Buzzes, Rattles and Objectionable Distortion: Apply a slow sine wave sweep from 50 to 5,000 Hz at a level 6 dB below rated power amplifier output voltage. Listen carefully for buzzes, rattles, and objectionable distortion. Correct any causes of these defects, unless the cause is clearly outside the sound amplification system equipment and installation, in which case, the cause shall be brought to the attention of the Consultant.

Gain Control Settings: Establish tentative normal settings for all gain controls. All gain controls on rack-mounted equipment shall be adjusted for optimum signal-to-noise ratio and signal balance. Settings may require further adjustment by the AV Contractor as a result of testing by the Consultant. After final gain and attenuator settings have been established, mark all control settings with an adhesive indicator dot or arrow.

Freedom from Switching Transient Noise: Operate all control switches and relays, while listening for clicks and pops in the system outputs. Eliminate any found.

Listening Test: Listen to normal program material to be sure that there are no remaining defects.

Acoustical Tests:

Make all necessary adjustments to ensure proper operation of the system.

The overall space average acoustical frequency response within each area served shall be within the limits given below. Test signals shall be broad band "pink" noise applied to any system input. Measurements shall be made using 1/3 octave band filters centered on ANSI preferred frequencies.

Throughout the coverage area of the Auditorium system, amplified sound levels shall not vary more than +/-3 dB as measured using an octave band of "pink" noise centered at 4,000 Hz as the test signal.

Measurements of system performance will be made using a calibrated ANSI S1.4, Type I sound level meter set for "slow" meter damping and flat response. The microphone shall be positioned 4 feet above the floor within the area served by the system. All interior finishes and furnishings shall be in place, and the system gain shall be set to provide octave band levels at least 10 dB above background noise levels in any octave band at the measuring locations for these tests.

Report: Upon completion of above tests and any necessary adjustments, submit two copies of a written report presenting test results, including numerical values where necessary, for review by the Consultant prior to acceptance testing, final tuning and demonstration. With this report, submit written certification that the installation conforms to the requirements stated herein, is complete in all respects, and is ready for inspection, testing and final tuning.

3.4 CONSULTANT INSPECTION

Upon approval of the preliminary test report by the Consultant, schedule the initial post-construction Consultant site visit. During the visit, demonstrate the operation of each major component of the system and the completed installation. After demonstration, assist as required in the following acceptance tests:

Listening Tests: These tests may include speech intelligibility survey and subjective aural evaluations by observers at various positions under various operating conditions, using live speech and/or recorded music material.

Equipment Tests: Any measurements of frequency response, distortion, noise or other characteristics and any operational tests deemed necessary may be performed on any item or group of items to determine conformity with these requirements.

If the need for adjustment or modification becomes evident during demonstration and testing, continue working until the installation operates fully in accordance with the requirement of this specification. The Consultant will prepare a punch list detailing any deficiencies found during the test phase.

The Contractor shall provide a technician familiar with the Work during the test, tuning, and equalization procedure. It is estimated that this technician should be available for approximately two (2) eight (8) hour days. This time shall be solely dedicated to the consultant inspection procedure and does not include time spent making the system functional or completing items on the test phase punch list.

3.5 DOCUMENTATION

Project Record:

The Contractor shall supply clean As-Built prints of the system drawings which show all changes which were made during fabrication and installation.

The Contractor shall supply clean prints of all previously submitted and approved shop drawings, revised to show all changes which were made during fabrication and installation.

Maintenance Information:

The Contractor shall provide technical information for all electronic apparatus, including but not limited to schematic diagrams and parts lists, manufacturer's installation instructions, operating instructions and technical specifications.

The Contractor submittal shall include all shop drawings prepared and used by the Contractor, as well as those which were not required to be submitted for approval. This shall include, but not be limited to, wiring diagrams, schedules for identification of building wiring and installation details useful to a maintenance technician.

Instruction Manuals:

Provide three (3) copies of an Instruction Manual to the Owner containing the following:

Table of Contents.

Instructions for operating the system in all modes of operation and for fulfilling all functional requirements.

List of settings and adjustments for semifixed controls.

Manufacturer's sheets of specifications, operating instructions, and service information arranged alphabetically by manufacturer and then by model number.

Detailed wiring diagrams and the simplified one-line diagram.

3.6 TRAINING AND INSTRUCTION

A minimum of twelve (12) hours of training shall be provided by the AV Contractor to Owner-designated representatives for all installed systems at a time mutually agreed upon between Owner and AV Contractor. The total training time may require that the training be broken into multiple sessions the total training time may require that the training be broken into multiple sessions. AV contractor is responsible for onsite manufacturer training if contractor is unfamiliar with the full operation of any equipment, such as digital mixing consoles.

All training will be recorded on DVD or media approved by the Owner and provided by the AV Contractor. AV Contractor shall provide two (2) copies of the training video on DVD or approved media to the Owner. The Contractor will supply the equipment necessary to record the training session(s).

During the training, the participants shall be given opportunities for "hands-on" experience with operating the controls. There shall be visual and audible demonstrations using the systems themselves as aids. Personnel for instruction and training for the AV systems shall be designated by the Owner.

END OF SECTION 27 41 16

SECTION 27 51 29

EMERGENCY COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

This Section includes requirements for the Emergency Communications System.

1.1 RELATED SECTIONS

Related Sections include, but are not limited to, the following:

This Section provides supplemental information to the Division 27 Specification Section *Basic Communications Requirements*.

1.2 SUBMITTALS

In addition to the criteria set forth for Submittals in Division 27 Specification Section *Basic Communications Requirements*, provide the following:

Shop Drawings: In addition to that called for in the Specification Section above, provide the following:

Floor / reflected ceiling plans indicating equipment locations.
One-line diagrams detailing the interconnections of the Emergency Communications system components. Identify all devices, cabling, terminations, and termination techniques as required to provide a fully functional system.
Detail drawings, including dimensional identification and intended installation methods.

1.3 RECORD DOCUMENTS

Comply with the criteria set forth for Record Documents in Division 27 Specification Section *Basic Communications Requirements*.

1.4 OPERATION AND MAINTENANCE MANUALS

Comply with the criteria set forth for Operation and Maintenance Manuals in Division 27 Specification Section *Basic Communications Requirements*. For backbone cables: Labels shall be affixed or engraved on hard plastic markers.

1.5 SYSTEM DESCRIPTION.

The unit shall be a vandal-resistant communications device that is a multi-functional, freestanding pedestal constructed of carbon steel. It shall include a high quality, hands-free communications device illuminated by a high intensity faceplate light and a powerful combination blue beacon/strobe light that serves to easily identify it from a distance.

The unit shall have a vandal-resistant, high quality, DSP-based full duplex IP speakerphone, intercom and paging device with advanced protocol support. It shall have a real time, non-open source, proprietary operating system. It shall have a single enclosure comprised of all electronics with serviceable speaker, microphone, button, and PCB components.

1.6 QUALITY ASSURANCE

All tower installation, configurations, setup, program and related work shall be performed by electronic technicians thoroughly trained by the manufacturer in the installation and service of the equipment provided.

The tower unit shall be warrantied against any defects in material and workmanship, under normal use, for a period of 2 years from date of installation. If system is found by manufacturer to be defective within the warranty period, manufacturer shall repair and/or replace any defective parts, provided the equipment is returned to manufacturer.

Manufacturer: Unless otherwise indicated, equipment in this Section shall be the standard products of a manufacturer regularly engaged in the manufacture of such products. All components used in the system shall be commercial designs that comply with the Specifications. Each major component of equipment shall identify the manufacturer's name, model, and serial number. Items of the same classification shall be identical. This includes equipment, modules, parts, and components. The Engineer retains the right to reject products which reflect, in the Engineer's opinion, sub-standard design practices, manufacturing procedures, support services, or warranty policies.

Unless otherwise indicated, the equipment by the following manufacturer shall not be substituted. The Contractor shall provide the most current model and/or version of product available by listed manufacturer at time of procurement:

Model CB 5-S from Code Blue Corporation

1.7 CERTIFICATIONS AND STANDARDS

The included LED blue light shall be certified to:

Americans with Disabilities Act (ADA) compliant
UL 60950-1 and UL 2017 listed
NFPA 72 Chapter 24 (2010) compliant
Meets NEMA 4 requirements

PART 2 - PRODUCTS

The Tower Unit shall:

Be constructed of ASTM A500 seamless carbon steel structural tube, schedule 20, 8.625" outside diameter x 0.25" thick wall, at a height of 114" and weigh approximately 220 lbs.
Have an internal anchor base plate that is MIG welded 2" above the base and fabricated with a minimum of 0.50" thick A-36 grade steel plate. It shall have a 4" diameter center hole for electrical conduit access. The base plate shall have three oblong holes on a 6" circular bolt pattern for attachment.
Have an access door measuring 15" H x 6.63" W will be placed 10" from the bottom of the base to provide access for mounting to the anchor bolts and connectivity to electrical facilities. The opening shall have a cover plate, which mounts flush and is the same steel and radius as the unit. The cover plate shall fit into the opening and have a weather-resistant gasket. The cover plate shall be held in place by two ¼-20 x 1" countersunk proprietary fasteners.
Have tamper resistant proprietary fasteners manufactured for Code Blue Corporation shall be used. It shall not be possible to acquire the custom-designed bit from any other source.
Have a recessed opening shall be cut at a point beginning 37.38" above the bottom of the unit. The opening shall be 14" tall at the forward edge and 12.38" tall at the rear edge, creating a 25-degree angle from the horizontal and an arc of 160 degrees in the face.

The Tower Unit Mounting shall:

Be mounted onto three anchor bolts that are set 0.50" above the concrete. Standard 0.75" x 24" galvanized steel anchor bolts, nuts and washers shall be supplied.

The concrete foundation shall measure 24” x 24” minimum and the anchor bolts shall protrude 6” from the foundation.

The Tower Unit Blue Light shall:

LED Beacon/Strobe: It shall have a rating of no less than 270 Lumens/92 candela, a factory-set flash rate of up to 375 flashes per minute and be programmable. A deep blue UV-rated polycarbonate prismatic refractor shall surround the LED Beacon/Strobe and be used to distribute the light in a horizontal pattern for maximum brightness and visibility.

The communication device shall be factory programmed to activate the LED Beacon/Strobe for the duration of a call.
The LED Beacon/Strobe shall be 5.10” tall and 5.50” in diameter.
Optional 0.25” steel round powder coated blue cage available to connect to the top with security screws to protect light from vandalism.

Faceplate light: LED will direct light onto the communications device and be vandal resistant.

The opening shall measure 4.50” W x .50” H
The light shall have a lifetime of 100,000 hours and a rating of 100 Lumens.

The Tower Unit Communications shall:

Have a speakerphone communication device.

IP5000 – SIP compatible VoIP speaker phone

EIA/TIA, ANSI, CSA and BICSI cabling or similar standards shall be adhered to for proper operation of devices connected to copper or fiber infrastructure.

The Tower Unit Finish shall:

Four-coat paint process, with zinc-rich primer for corrosion resistance and baked-on polyurethane enamel for maximum gloss and shine.

Optional clear coating process available to provide additional environmental protection.

Substrate preparation shall be as required to comply with applicable ASTM impact and adhesion standards: D2794 Direct and Reverse Impact, D523 Gloss @ 60 Degrees, D3359B Cross hatch Adhesion, D1654 Corrosion Creep, D714 Scribe Blisters and D714 Field Blisters.
The finish shall be standard color: Safety Blue.
Minimum coverage thickness of 2.0 mils.

The Tower Unit Graphics Shall have:

Engineering grade reflective vinyl for high visibility and legibility.
Standard 3.25” tall and 30” long graphics text shall be: “CALL FOR HELP”.
Standard graphics color: Reflective White.

PART 3 - EXECUTION

3.1 INSTALLATION

The Contractor shall carefully follow instructions in documentation provided by the manufacturer to ensure all steps have been taken to provide a reliable, easy-to-operate system.

All equipment shall be tested and configured in accordance with instructions provided by the manufacturer prior to installation.

END OF SECTION 27 51 29

SECTION 28 00 00

SECURITY GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

This Section specifies the general requirements for Security Systems.

Provide all labor, materials, equipment, tools and services required for the installation of the Security Systems.

Contractor personnel assigned to device programming and hardware/software installation shall have been certified in these tasks by the Manufacturer or possess industry certifications acceptable to the Manufacturer and the Owner attesting to the necessary competence.

1.2 RELATED SECTIONS

Division 8 Specification Section 08 71 00 *Door Hardware*. Provide coordination as required to support the work of this Section.

Division 27 Specification Section 27 00 10 *Basic Communications Requirements*. Provide cabling coordination as required to support the work of this Section.

Division 27 Specification Section 27 04 05 *Common Work - Sleeves, Penetrations and Firestopping*. Provide sleeves, penetrations, and firestopping as required to support the work of this Section.

Division 27 Specification Section 27 04 06 *Common Work – Hangers and Supports*. Provide hangers and supports as required to support the work of this Section.

1.3 SUBMITTALS

Provide the following per the criteria set forth in Submittals in Division 27 Specification Section 27 00 10 *Basic Communications Requirements*:

Product Data
Shop Drawings

1.4 RECORD DOCUMENTS

Provide Record Documents per the criteria set forth for Record Documents in Division 27 Specification Section 27 00 10 *Basic Communications Requirements.*

1.5 OPERATION AND MAINTENANCE MANUALS

Provide Operation and Maintenance Manuals per the criteria set forth for Operation and Maintenance Manuals in Division 27 Specification Section 27 00 10 *Basic Communications Requirements*.

1.6 WARRANTY

Provide warranty support per the criteria set forth for Warranty in Division 27 Specification Section *27 00 40 Warranty*.

1.7 TRAINING

Provide system training per the criteria set forth for Training in Division 27 Specification Section *27 00 60 Training*.

PART 2 - MATERIALS

2.1 GENERAL

Plenum Rating:

Cable shall be plenum rated unless otherwise indicated. Cable shall bear plenum markings.
Supports, incidental materials, cable ties and cable retainers shall be plenum rated to match that of associated cable.

PART 3 - EXECUTION

3.1 GENERAL

Work shall comply with the Governing Requirements as defined in Division 27 Specification Section 27 00 10 *Basic Communication Requirements*. Governing Requirements of particular relevance to this Section include, but are not limited to:

IBC: International Building Code
IEEE C62.41: Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits
IEEE 802.1x: Standard for Port Based Network Access Control
NFPA 72: National Fire Alarm and Signaling Code
NFPA 731: Standard for the Installation of Electronic Premises Security Systems
NFPA 101: Life Safety Code
UL 294: Standard for Access Control System Units
UL 497B: Protectors for Data Communications and Fire-Alarm Circuits
UL 1449: Transient Voltage Surge Suppressors
UL 2900-2-3: Outline of Investigation for Software Cybersecurity for Network-Connectable Products, Part 2-3: Particular Requirements for Security and Life Safety Signaling Systems

3.2 SOFTWARE IMPLEMENTATION

The Contractor shall provide all software configurations as required to provide a fully functional and operating system ready for the Owner's use. Software configuration shall include but not be limited to Cybersecurity, encryption, firmware, data communication, operating system settings, manufacturer approved installation practices. Existing Security Systems shall be incorporated into new/expansion systems, as required.

3.3 HARDWARE CONFIGURATION

The Contractor shall provide all hardware configurations as required to provide a fully functional and operating system ready for the Owner's use. Hardware configuration shall include but not be limited to Cybersecurity configuration, data communication, system settings, power distribution and manufacturer approved installation practices. Existing Security Systems shall be incorporated into new/expansion systems, as required.

3.4 INSTALLATION

Pathways: Prior to the installation of Security Systems cabling, Contractor shall verify conduit sizing and quantity for correctness. Deviations from the design documents shall be documented and Contractor shall contact Engineer with notification of deviation.

Cabling:

Security Systems cabling that is not network-based (i.e. Category 5E, 6, etc.) shall maintain separation from other system cabling and shall route within dedicated Security System pathways.
Cable pulls shall be conducted within the following requirements:

Manufacturer's guidelines for pulling tension and bend radii.
NEC conduit fill standards. Contractor shall notify Engineer prior to cable installation when conduits are found to be undersized.
Any cable found to be faulty due to poor cable installation practices shall be removed and replace at no additional cost to Owner.

Cable splicing shall not be considered a common installation practice. If necessary, splice cables only in junction boxes or racks. Shielded cables shall not be spliced; instead each end shall be terminated with an appropriate connector to maintain shield continuity. Any cable found to be faulty due to splicing shall be removed and replaced at no additional cost to Owner.
The Contractor shall dress all cables at both ends with:

Black heat shrink where jacketing has been stripped away to expose individual conductors
Clear heat shrink where shields have been exposed (Coax excluded)
Printed, adhesive labels with clear heat shrink over each label

Contractor shall make all terminations with rosin-core solder, crimp/compression type connectors or captive screw type mechanical connections. For captive screw type mechanical connection, use spade type or ferrules type crimp terminations. Bare wire terminations are not acceptable.

Equipment:

Equipment shall be installed as indicated and specified, and in accordance with the manufacture's recommendations, except where local codes or regulations take precedence.
Place equipment labels or other identification where the label or identification can be easily seen and read without difficulty.
Equipment shall be installed level, plumb, parallel, and perpendicular to building structures and to other building systems and components, except where otherwise indicated.
Equipment shall be securely fastened. Select fasteners and supports so that the load applied to any one fastener maintains a minimum load factor of five.
Equipment locations: Prior to installation of Security System equipment, Contractor shall coordinate with other trades and subsequently verify all equipment locations that mount on walls or within ceilings. This shall include but not be limited to:

Structural elements such as lighting devices, HVAC equipment, fire protection devices, and cable tray
Structural support elements for ceiling mounted devices
Backing Board for wall mounted devices

Prior to head-end equipment installation, contractor shall verify equipment rooms are and will remain free of airborne contaminants.
After head-end equipment installation, contractor shall protect equipment from any future construction work that could cause damage to equipment, i.e. masonry, wood, paint, plumbing, etc.
Prior to furniture work, Contractor shall coordinate with other trades and subsequently verify all equipment locations that mount within furniture.
Contractor shall coordinate with architect as to any equipment color and finish requirements.
Any equipment exposed to tampering or indicated as tamper or vandal proof shall be installed with tamper/vandal proof enclosures and secured using pin-head Torx fasteners suitable for the material and load requirements.

Software:

Contractor personnel shall comply with all applicable state and local licensing requirements.
Contractor personnel assigned to device programming and software installation shall have been certified in these tasks by the Manufacturer or possess industry certifications acceptable to the Manufacturer and the Owner attesting to the necessary competence.
Installers shall follow all recommended procedures and guidelines from the Manufacturer to securely provision network connected products.
The Contractor and its authorized installers shall:

Follow an Owner-approved password provisioning plan
Complete the owner-approved asset management worksheet to include:

Manufacturer, model, and firmware or software version
Serial number and MAC address, if applicable
Network settings, including IP address, VLAN or subnet mask, default gateway
Equipment locations shall be coordinated with the Owner
Device user names and passwords (Alternatively, if the worksheet is not protected, user names and passwords should be provided via a secured means to the Owner)

All security device passwords shall be changed from default and follow strong enforcement standards approved by the Owner
Synchronize security devices with a common time base acceptable to the Owner
Disable all services and ports not required for ongoing system operation
Provision device and system privileges in a manner approved by the Owner

Grounding and Surge Protection:

The Contractor shall follow accepted engineering practices when installing the Security Systems grounding system. The security grounding system installation shall conform to NEC standards. The contractor shall be responsible for correcting any grounding problems within the Security System including but not limited to electromagnetic/electrostatic interference, ground loops anomalies, and distortions.
All devices installed to the exterior of structure shall be protected from surge voltages with surge suppression devices. Install surge suppression devices in strict accordance with the manufacturer requirements.
All solenoid or coil driven devices (i.e. door strikes, pin bolt locks, large relays, gate operators and magnetic locks) shall be installed with metal oxide varistors for surge suppression.

Structural Installations

Structural support elements are defined as those materials added to structure for the reinforcement of general construction methods to meet a designed minimum load factor of five. These include but are not limited to:

Backing boards required for the support of Security System equipment and cabling
Strut supports hung from structural beams or concrete slab

It is the Electrical Contractor's responsibility to provide structural support elements for the Security Systems equipment.
The Contractor is to provide all Security Systems mounting and rigging equipment that fasten to the structural support elements.
All support elements and fastenings shall be able to support a minimum load factor of five times the total assembled weight of the Security System equipment.
The Contractor shall be responsible for the complete and correct installation of all Security Systems equipment.

3.5 TESTING

Operational Testing

Prior to system training and acceptance testing, the Contractor shall perform and document operational testing.

Video Surveillance Systems

Contractor shall produce a checklist for testing and documentation of all Video Surveillance Systems equipment. Each device shall be verified for proper operation at monitoring stations and camera locations. Devices under test shall consist of but shall not be limited to: cameras, camera power, video recording devices, monitoring devices and control system operation.
Contractor shall correct any defective device upon discovery. Contractor shall notify and coordinate with other trades to ensure faulty devices are put into working order.
Contractor shall test and document all data transmissions for proper operation. Correct any defect upon discovery.
Contractor shall conduct operational testing, in accordance with the manufactures approved test recommendations.

Access Control System

Contractor shall assemble the following test equipment:

Ground fault indicator
Digital Multi-meter

Prior to any connections being made to building power, Contractor shall use a ground fault indicator to verify the circuits are properly grounded wiring. If grounding is found to be faulty, the contractor shall notify the electrical contractor. Connections shall not be made to building power until proper grounding is demonstrated.

The Contractor shall produce a checklist for testing and documentation of all Access Control System equipment. Each device shall be verified for proper operation at the monitoring stations and the door locations. Devices under test shall consist of, but not be limited to card readers, locking mechanisms, door position switches, request to exit devices, auto operators, handicap paddles, crash bars with switches, and overhead door operators.

The Contractor shall correct any defective device upon discovery. The Contractor shall notify and coordinate with other trades as necessary to ensure faulty devices are put into working order.

The Contractor shall test and document all “end of line resistance” values in all states of operation, where applicable. Correct any defect upon discovery.

The Contractor shall test and document all data transmissions for proper operation. Correct any defect upon discovery.

The Contractor shall conduct operational testing, in accordance with manufacturer approved test recommendations.

Intercom System

The Contractor shall produce a checklist for testing and documentation of all Intercom System equipment. Each device shall be verified for proper operation at the master stations and the call station locations. Devices under test shall consist of, but not be limited to system head end equipment, Master Audio/Video Stations, Call Audio/Video Stations.

The Contractor shall correct any defective device upon discovery. The Contractor shall notify and coordinate with other trades as necessary to ensure faulty devices are put into working order.

The Contractor shall test and document all data transmissions for proper operation. Correct any defect upon discovery.

The Contractor shall conduct operational testing, in accordance with manufacturer approved test recommendations.

Acceptance Testing

System acceptance testing shall not be conducted until all final “as-built” drawings, manuals and operational testing have been completed and the documentation has been submitted for Engineer’s review.

Acceptance testing shall be conducted with Contractor, Engineer, and Owner in attendance.

Contractor shall demonstrate that all components of the Security System are in proper working order and are in accordance with specifications.

For systems requiring battery standby power, a battery test shall be automatically performed to test the standby battery integrity. The test shall disconnect the standby battery from the charging circuit and place a load on the battery per UL requirements.

At time of acceptance testing, all items found to be outside of specification requirements; Owner requirements, code requirements or general installation practices shall be added as new items to the final Punch List. All items found outside of specification requirements shall be put into working order prior to final acceptance of system.

The Contractor shall assemble an inventory of installed equipment. This inventory shall be compiled at time of acceptance testing and compared to equipment listed in contractual documents.

Acceptance testing may be suspended by Engineer if Security Systems are not complete and operable, equipment failure occurs, or installation is not in accordance with specifications. Contractor shall be responsible for any cost incurred by Engineer for additional site visits required to complete acceptance testing.

In conjunction with the Owner’s IT Department, the Contractor shall arrange for a post-installation vulnerability test to verify that additional cyber vulnerabilities have not been introduced into the Owner’s network as a result of this project.

END OF SECTION 28 00 00

SECTION 28 10 00

SECURITY - ACCESS CONTROL SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

This Section defines the Security System requirement for the Access Control System.

1.2 RELATED SECTIONS

The requirements of Division 28 Specification Section *Security - General Requirements* shall serve as the basis for the requirements of this Section and are incorporated by reference into this Section.

1.3 SUBMITTALS

Provide the following per the criteria set forth for Submittals in Division 28 Specification Section Basic Requirements:

Product Data
Shop Drawings

1.4 SYSTEM DESCRIPTION

Summary: A new Access Control System shall be provided within this facility. All system components of the new Access Control System shall be compatible with the existing campus standards. The new Access Control System head-end equipment shall reside within this facility and communicate with a new Access Control System database via the Owner's data network. The Security Contractor shall provide a fully functional and operating system ready for the Owner's use. The Security Contractor shall coordinate with the Owner for system installation requirements including, but not limited to: installation, programming, and system training.

The Access Control System shall interface with other systems within the facility. Systems shall interface through hardware connectivity including but not limited to network / serial communication, contact closure and voltage / ground reference, The Security Contractor shall closely coordinate with other trades to ensure a fully functional, operating and integrated system ready for the Owner's use. The Access Control System shall interface with the following systems:

Intercom System: Provide door control through intercom station communication.
Fire Alarm System: The Access Control System shall interface with the Fire Alarm equipment (through relay activation provided by the Fire Alarm Contractor) in the event of a fire alarm. The Security Contractor shall coordinate the functionality of the Access Control System during the activation of the fire alarm with Authorities Having Jurisdiction, Fire Alarm Contractor, and the Owner.

The primary function of the Access Control System is to secure / monitor selected building entry locations from unauthorized entry. The Access Control System shall include but not be limited to a database application(s), access control processing equipment, communication equipment, verification devices, monitoring station(s), power supplies, any necessary cabling and door hardware equipment to provide a fully functional and operating system ready for the Owner's use.

The new Access Control System shall reside locally within this facility, including but not limited to:

Software:

Access Control System Software: Software require for the direct operation of the local Access Control System head-end equipment which shall include but not be limited to: programming, troubleshooting, testing and verification of system operation.
Server operating system software: Server operating system software required to install Access Control System database applications onto
Database: Database install and configuration requirements, which shall include, but not limited to: programming, troubleshooting, testing and verification of system operation.
Software upgrades: A software upgrade package shall be valid for the duration of the warranty period. The Security Contractor shall purchase the software upgrade package in the Owner's name and provide documentation and renewal information to the Owner at acceptance testing. The Security Contractor shall install all software upgrades in a timely manner upon availability.
Software licenses: Software licenses required for the new Access Control System including but not limited to:

- Site License
- Client Licenses
- Reader Licenses

Hardware:

Head-end equipment: Equipment required for the direct operation of the Access Control System.
Server equipment: Server equipment required for the Access Control System database operation.

The Access Control System shall operate within the parameters set forth below:

The Access Control System shall be capable of standalone operation in the event that communication is interrupted between the local system and the Network Database.
The head-end Access Control System equipment (to include Panels and Servers) shall have battery back-up power for a minimum of 1 hour of continued operation of the entire system in the event of a power outage. This does not apply to lock power supplies unless specifically required.
The Access Control System shall provide monitoring of the facility to include but not be limited to:

Events within standard door operation: the following actions shall occur upon a valid card read:

Door alarm shall be shunted and return to alarmed state after door closure.
An icon on a graphical map shall indicate a valid entry.
Card holder information shall display at all Monitoring Stations, as applicable.
Card holder information shall register within an events log.

Events outside of standard door operation: the following actions shall occur upon an unsecure status including but not limited to force open, hold open and latch obstruction situations:

A visual / audible notification shall display at all Monitoring Station, if applicable.
An icon on a graphical map shall indicate an invalid entry and notify personnel of alarm.
The event shall register within an events log.

The Security Contractor shall provide connectivity to all door hardware, as applicable, to ensure the Access Control System operates within the parameters set forth herein. The Security Contractor shall coordinate with the Door Hardware Contractor to ensure all door hardware is provided and operates as indicated in the Construction Documents. The Access Control System shall provide operation for doors consistent with but not limited to the following:

Secured side access:

The door shall remain locked to unauthorized personal at all times except during times of building operation. Coordinate building operation schedule with Owner.
Authorized personnel shall present badge to card reader unit, upon database verification, access shall be granted. The automatic door opener feature, if applicable, shall be available only after personnel are granted access. The door shall remain unsecured for the owner determined number of seconds before returning to a secure state.
Fail Secure doors shall remain secure in the event of a power outage, unless determined otherwise.
Fail Safe doors shall not be connected to battery backup in any manner.

Unsecured side access:

The door shall provide free egress from building at all times.
Egress shall be provided by means of a mechanical release located within the door hardware (non-magnetic locks) or an electromechanical switch located within door handle, exit device or door frame (magnetic locks).
The automatic door opener feature, if applicable, shall be available at all times.

The Access Control System shall provide capability for reporting a Duress situation. The Owner's Duress procedural standards shall set the precedence to which the Access Control System shall be programmed and / or configured. The system shall provide but not be limited to:

Duress buttons as shown in specific locations noted on the drawings shall notify the security office of the active event and location through an audible / visual alert on the monitoring station.

The Access Control System shall provide capability for a "Lock Down" situation. The Owner's "Lock Down" procedural standards shall set the precedence to which the Access Control System shall be programmed and / or configured. The system shall provide but not be limited to:

Initiation of the "Lock Down" operations
Release all door hold open hardware
Secure all controlled doors (i.e. disable schedule events)
Integration with the Public Address System to initiate "Lock Down" warning page if requested

The Access Control System Management / Monitoring Station shall be located within the Security Office. The Station shall consist of but not be limited to a computer(s), LCD monitor(s), and Monitoring Software. All components necessary for a fully functional and operational Monitoring Station shall be provided by the Owner.

Graphical mapping: Provide graphical mapping of facility with security point icons to indicate locations of status of operation, valid access, invalid access and alarm events. Icons shall be selectable to provide control of entry and response to alarms. Coordinate with Owner for additional requirements.

PART 2 - Materials

2.1 GENERAL

Manufacturer: Unless otherwise indicated, equipment in this Section shall be the standard products of a manufacturer regularly engaged in the manufacture of such products. All components used in the system shall be commercial designs that comply with the Specifications. Each major component of equipment shall identify the manufacturer's name, model and serial number. Items of the same classification shall be identical. This includes equipment, modules, parts, and components. The Engineer retains the right to reject products which reflect, in the Engineer's opinion, sub-standard design practices, manufacturing procedures, support services, or warranty policies.

Unless otherwise indicated, the equipment by the following manufacturers shall not be substituted. The Security Contractor shall provide the most current model and/or version of product available by listed manufacturer at time of procurement:

Paxton

Equipment Schedule(s): The equipment schedule(s) on Drawings is general in nature and is provided to define system requirements, including but not limited to: functionality, signal compatibility, mounting requirements, space requirements, cooling requirements and overall clarity / intent of operation. The equipment schedule(s) is not all inclusive and is not to be used as a bill of materials. The Security Contractor shall provide all equipment required for a fully functional and operating system ready for the Owner's use that may or may not be explicitly specified within Construction Documents.

Part Numbers: Refer to the equipment schedule(s) for specific part numbers. Part numbers listed in the equipment schedule(s) define the performance specifications for the parts and shall be per the most recent manufacturer's cut/data specification sheets available at the time of bid. If no part number is provided, then any part meeting the functional and operational requirements specified is acceptable.
Provide materials in quantities as required to provide a fully functional and operational System.
Owner Furnished Contractor Installed (OFCI): Refer to the equipment schedule(s) on Drawings for procurement requirements. Equipment identified as "OFCI" shall be provided by Owner for the Security Contractor to install.

2.2 EQUIPMENT SPECIFICATIONS

This equipment shall as a minimum conform to the following specifications:

Access Control Processing Equipment

The access control processing equipment shall provide capacity for current door requirements as referenced in drawings with the ability to expand for future Access Control needs.

The processing equipment shall have a dedicated Class II power supply with battery charger.
Security Contractor to verify power requirements of processing equipment prior to installation and shall include battery calculations for standby power in design submittals.

Auxiliary Relay

The relay shall be of a blade type construction with a double pole, double throw contact configuration.
The coil and contact ratings shall exceed the inline current and voltage requirement of the relay-controlled devices.

Card Reader

The card reader shall be a proximity type card reader.
The card reader shall have battery backup power in the event of power outages.

Access Control Cards

Access control cards (badges) shall be proximity type cards that match the requirements of the access control processing equipment, software and card
Access control cards shall match any Owner existing cards / standards.
Coordinate with the owner prior to furnishing.

Card Printer

The card printer shall have the ability to print and encode superior quality, high durable ID cards with the capability for upgrades with additional modules.
The Security Contractor shall identify specific requirements/standards for the Owner to ensure proper design and operation.
The card printer shall be able to produce new cards that match the Owner's existing cards / standards.

Lock Power Supply

The lock power supply shall be a dedicated, voltage selectable Class II power supply with battery charger capable of providing power to multiple door locks (typically 8 or 16).
The Security Contractor shall verify power requirements of processing equipment prior to installation and shall include battery calculations for standby power in design submittals.
Any failsafe doors shall unlock on power loss or fire alarm and therefore shall not be on any backup power source.

Management / Monitoring Station

Software

The Security Contractor shall provide software (and licenses if applicable) to support the Management Station(s).
The software shall be of the same manufacturer as the Access Control System.
The software shall provide the ability to issue/manage access control cards and card holder information.
The software shall provide the ability to manage door operation.
The software shall provide real-time monitoring of select doors.

The software shall provide floor plan maps with icons that will alert operators where the system has detected a breach in security.

Computer

The Owner shall provide the computer onto which the management software shall be installed. The Security Contractor shall provide installation and configuration of software for operation of the Monitoring Station.
The computer shall exceed the minimal requirements of the monitoring software as specified by manufacturer.
The Security Contractor shall provide installation and configuration of software for operation of the Card printing/issuing (if separate from management software) ready for Owner's use.

2.3 WIRE AND CABLE

This equipment shall at a minimum conform to the following specifications. Cable gauge and conductor quantity requirements may vary depending on device requirements. The Security Contractor to determine and utilize cable with proper conductor and gauge requirements to provide proper operation.

Contact Closure cabling: This cable shall be per Manufacturer's recommendations, minimum requirements: Shielded Twisted Pair, (2) 22 AWG stranded conductor.
Power cabling: This cable shall be Per Manufacturer's recommendations, minimum requirements: Unshielded Twisted Non-Pair, (2) 18 AWG stranded conductors.
Access Control cabling shall be yellow composite plenum consisting of a 22-6 shielded, 22-4 unshielded, 18-4 unshielded and a 22-2 unshielded.

PART 3 - EXECUTION

3.1 GENERAL

The Security Contractor shall closely coordinate with the Owner to ensure that Owner provided equipment is procured, configured (as necessary), and installed (as necessary) with ample lead time prior to the Security Contractor's use of the equipment.

The Security Contractor shall closely coordinate with the Authority Having Jurisdiction to ensure that all local codes and building requirements are met. The Security Contractor shall provide all documentation required for permitting and to pass Certificate of Occupancy.

Refer to Division 28 Specification Section - *Security General Requirements* for execution requirements.

END OF SECTION 28 10 00

SECTION 28 15 23

INTERCOM SYSTEM - GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

This Section includes requirements for the Intercom System.

1.2 RELATED SECTIONS

The requirements of Division 28 Specification Section *Security - General Requirements* shall serve as the basis for the requirements of this Section and are incorporated by reference into this Section.

1.3 SUBMITTALS

Provide the following per the criteria set forth for Submittals in Division 28 Specification Section Basic Requirements:

Product Data
Shop Drawings

1.4 SYSTEM DESCRIPTION

Summary: A new Intercom system shall be provided within this facility. The system shall be hands free at the remote Calling Station after initiation to the Master Station. The Master Station shall provide individual selection to communicate with each remote Call Station. The system shall utilize video capability between stations. The following components shall be included:

System Software

Shall be provided for programming of selected features.
Shall allow master station forwarding of calls when master station is unattended.
Shall allow integration with the Paxton Access Control System for door control and operation.

System Security Relay Adapter (if applicable)

Shall be provided on the secure side of the door to prevent any attempt to gain access by tampering with the call station.
Shall cut off the connection to the door strike and ensure that the door remains securely locked.

Intercom Master Station(s)

Shall receive calls from remote stations by selective indication of the calling location.
Shall be provided with a door open feature that will allow the intercom master, while in communication with the remote station, to unlock the door.
Shall automatically annunciate the calling station.

Intercom Call Station(s)

Shall place calls to selective master stations.
Shall have hands free operation upon connection with the master station.

The Intercom System shall integrate with the following system(s):

Access Control System

PART 2 - MATERIALS

2.1 GENERAL

Manufacturer: Unless otherwise indicated, equipment in this Section shall be the standard products of a manufacturer regularly engaged in the manufacture of such products. All components used in the system shall be commercial designs that comply with the Specifications. Each major component of equipment shall identify the manufacturer's name, model and serial number. Items of the same classification shall be identical. This includes equipment, modules, parts, and components. The Engineer retains the right to reject products which reflect, in the Engineer's opinion, sub-standard design practices, manufacturing procedures, support services, or warranty policies.

Unless otherwise indicated, the equipment by the following manufacturers shall not be substituted. The Contractor shall provide the most current model and/or version of product available by listed manufacturer at time of procurement:

Paxton

Equipment Schedule(s): The equipment schedule(s) on Drawings is general in nature and is provided to define system requirements, including but not limited to: functionality, signal compatibility, mounting requirements, space requirements, cooling requirements and overall clarity / intent of operation. The equipment schedule(s) is not all inclusive and is not to be used as a bill of materials. The Contractor shall provide all equipment required for a fully functional and operating system ready for the Owner's use that may or may not be explicitly specified within Construction Documents.

Part Numbers: Refer to the equipment schedule(s) for specific part numbers. Part numbers listed in the equipment schedule(s) define the performance specifications for the parts and shall be per the most recent manufacturer's cut/data specification sheets available at the time of bid. If no part number is provided, then any part meeting the functional and operational requirements specified is acceptable.
Provide materials in quantities as required to provide a fully functional and operational System.

2.2 EQUIPMENT SPECIFICATIONS

This equipment shall as a minimum conform to the following specifications:

Call Stations

The intercom call stations shall be Power over Ethernet (PoE) and SIP capable. This shall enable any standard phone on the facility phone system to receive specific intercom station calls if required.

Master Stations

The intercom master station shall be PoE capable.
The intercom master station processing equipment shall provide capacity for current door requirements as referenced in drawings with the ability to expand for future intercom needs.

2.3 WIRE AND CABLE

This equipment shall as a minimum conform to the following specifications. Cable conductor and gauge requirements may vary depending on device requirements. Contractor to determine and utilize cables with proper conductor and gauge requirements to provide optimum operation of system devices.

Network Communications: The network communication cable shall conform to Division 27 Specification Section Communication – Horizontal Cabling.
Relay Control: The relay control cable shall be an Unshielded Twisted Non-Pair, two 18 AWG stranded conductor.

PART 3 - EXECUTION

3.1 GENERAL

The Contractor shall closely coordinate with the Owner to ensure that Owner provided equipment is procured, configured (as necessary), and installed (as necessary) with ample lead time prior to the Contractor's use of the equipment.

The Contractor shall closely coordinate with the Authority Having Jurisdiction to ensure that all local codes and building requirements are met. Contractor shall provide all documentation required to pass Certificate of Occupancy.

Refer to Division 28 Specification Section - *Security General Requirements* for execution requirements.

END OF SECTION 28 15 23

SECTION 28 20 00

SECURITY - VIDEO SURVEILLANCE SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

This Section defines the Security System requirement for the Video Surveillance System.

1.2 RELATED SECTIONS

The requirements of Division 28 Specification Section *Security - General Requirements* shall serve as the basis for the requirements of this Section and are incorporated by reference into this Section.

1.3 SUBMITTALS

Provide the following per the criteria set forth for Submittals in Division 28 Specification Section Basic Requirements:

Product Data
Shop Drawings

1.4 SYSTEM DESCRIPTION

Summary: A new Video Surveillance System shall be provided within this facility. All system components of the new Video Surveillance System shall be compatible with the existing campus standards. The new Video Surveillance System head-end equipment shall reside within this facility and communicate via the Owner's data network. The Security Contractor shall provide a fully functional and operating system ready for the Owner's use. The Security Contractor shall coordinate with the Owner for system installation requirements including, but not limited to: installation, programming, and system training.

The primary function of the Video Surveillance System is to monitor / record events within specified areas of the facility. The Video Surveillance System shall include but not be limited to recording / camera processing equipment, camera equipment, communication equipment, a monitoring station(s), power supplies and any necessary cabling to provide a fully functional and operating system ready for the Owner's use.

The new Video Surveillance System recording equipment shall reside locally within this facility, including but not limited to:

Software:

Video Surveillance System recording software: Camera recording application required to capture and store video / audio information from cameras.
Software licenses: Software licenses required for the new Video Surveillance System including but not limited to:

Site license
Client licenses
Camera license

Software upgrades: Software upgrade package shall be valid for the duration of the warranty period. The Security Contractor shall purchase the software upgrade package in the Owner's name and provide documentation and renewal information to the Owner at acceptance testing. The Security Contractor shall install all software upgrades in a timely manner upon availability.

Hardware:

Cameras: Cameras and camera accessories.
Servers / Storage: The server equipment required for the recording of security audio and video signals shall be provided by Owner.
Network switches: Network switches utilized for the transmission of security audio and video signals. Network switches shall provide power over Ethernet. Switch equipment shall be provided by Owner.

The Security Contractor shall provide communication via the Owner provided Data Network System. The Video Surveillance System shall utilize a virtual network within the facilities data network for video, data and communication transmission.

Structured Cabling: Structured cabling required for the direct operation of the Video Surveillance System shall be provided by the Telecommunication Contractor. Structured cabling shall include but not limited to fiber optic and copper cabling.
Data Communications Equipment: Data communications equipment required for the direct operation of the Data Network System shall be provided by the Owner. Data communication equipment shall include but not limited to repeaters, switches and routers.

The Security Contractor shall coordinate with the Owner to ensure all Data Network System requirements have been provided, this is to include but not limited to patch panel configuration, switch allocation, router allocation, IP addressing, Power over Ethernet (PoE) and network security.
Cameras shall utilize PoE when applicable. Where the Owner's network switch does not provide or provides inadequate PoE, the Security Contractor shall provide Ethernet PoE extenders.

The Video Surveillance System shall operate within the parameters set forth below:

The Video Surveillance System shall provide viewing of real-time and recorded events.
The Video Surveillance System shall have emergency power backup capabilities in the event of power outage.
Recording requirements: The Security Contractor shall coordinate recording requirements with the Owner. Minimum recording requirements shall include but not be limited to:

Video images shall be recorded at variable resolutions and frame rates.
Recorder shall provide audio / video recording.
Storage Calculation shall be based on the following:

7 frames per second at full resolution with up to 50 percent motion.
Recorded information shall be stored for a minimum of 21 days.

Event recording shall register within an events log.
Recorded information shall be transferable to long term storage.

Monitoring requirements: The Security Contractor shall coordinate monitoring requirements with the Owner. Minimum monitoring requirements shall include, but not be limited to:

Monitoring shall be provided remote of the recording equipment via the Data Network System.
Monitoring stations shall display multiple cameras on a single video display.
Monitoring stations shall provide customizable camera arrangements.
Events shall be identified on the video display.
Camera selection and view controls shall be available via the monitoring station software user interface.

The Video Surveillance System Monitoring Station(s) shall be located within the Security Office and Reception Desk. The Monitoring Station shall consist of but not be limited to a computer(s), LCD monitor(s), and Monitoring Software. All components necessary for a fully functional and operational Monitoring Station shall be provided by the Owner

PART 2 - MATERIALS

2.1 GENERAL

Manufacturer: Unless otherwise indicated, equipment in this Section shall be the standard products of a manufacturer regularly engaged in the manufacture of such products. All components used in the system shall be commercial designs that comply with the Specifications. Each major component of equipment shall identify the manufacturer's name, model and serial number. Items of the same classification shall be identical. This includes equipment, modules, parts, and components. The Engineer retains the right to reject products which reflect, in the Engineer's opinion, sub-standard design practices, manufacturing procedures, support services, or warranty policies.

Unless otherwise indicated, the equipment by the following manufacturers shall not be substituted. The Security Contractor shall provide the most current model and/or version of product available by listed manufacturer at time of procurement:

Milestone VMS
Axis Cameras

Equipment Schedule(s): The equipment schedule(s) on Drawings is general in nature and is provided to define system requirements, including but not limited to: functionality, signal compatibility, mounting requirements, space requirements, cooling requirements and overall clarity / intent of operation. The equipment schedule(s) is not all inclusive and is not to be used as a bill of materials. The Security Contractor shall provide all equipment required for a fully functional and operating system ready for the Owner's use that may or may not be explicitly specified within Construction Documents.

Part Numbers: Refer to the equipment schedule(s) on Drawings for specific part numbers. Part numbers listed in the equipment schedule(s) define the performance specifications for the parts and shall be per the most recent manufacturer's cut/data specification sheets available at the time of bid. If no part number is provided, then any part meeting the functional and operational requirements specified is acceptable.

Provide materials in quantities as required to provide a fully functional and operational System.
Owner Furnished Contractor Installed (OFCI): Refer to the equipment schedule(s) on Drawings for procurement requirements. Equipment identified as "OFCI" shall be provided by Owner for the Security Contractor to install.

2.2 EQUIPMENT SPECIFICATIONS

This equipment shall as a minimum conform to the following specifications:

Cameras

Fixed Network Camera

The interior camera shall be a network enabled camera with an integrated video codec.
The camera shall include but not be limited to the following specifications:

Resolution: Minimum of 1080P (2 MP) or higher based on application.
Frame Rate: Stream up to 30 frames per second
Video compression: MPEG-4 / H.264
Power: PoE Class 2 / Class 3
Network: IPv4/v6, QoS, 100Base-T Ethernet
ONVIF Profile S Conformant
Tamper/vandal resistant
IP66 Outdoor Rating (for exterior cameras)

The installation method for the interior camera shall include but not be limited to:

The cameras installed within drop tile ceilings and shall include appropriate mounting hardware and shall be affixed to structure with hanger wire.
The cameras installed onto walls or hard lid ceilings shall include appropriate mounting hardware and shall mount onto a standard electrical box.

The installation method for the exterior camera shall include but not be limited to:

Appropriate mounting hardware and grounding
Environmental protection including, but not limited to: IP66 outdoor rating, watertight cable pathways, watertight faceplates, watertight sealant and caulk.
The exterior camera shall be provided with surge protection.

Monitoring Station

Software

The software shall be of the same manufacturer as the Network Video Recorder Software.
The software shall provide viewing of all cameras in real-time and also playback of recorded events.
The software shall provide pan-tilt-zoom camera control.
The software shall provide administration of video recorder set-up.
The software shall provide notification of alarms from integrated external devices.
The software shall be capable of importing CAD or other maps for use in alarm identification.

Computer

The computer shall exceed the minimal requirements of the monitoring software as specified by manufacturer.

Processor: Provide processor(s) that exceeds the VMS software manufacturer's minimum requirements for quantity of cameras and quality and resolution of image.
RAM: Provide Random Access Memory (RAM) that exceeds the VMS software manufacturer's minimum requirements for quantity of cameras and quality and resolution of image. Typically, a minimum of 4GB.
Hard drive: Minimum 50 GB free hard disk space shall be available (depends on number of servers, cameras, rules, and logging settings).
CPU: Minimum Intel Pentium 4, 2.4 GHz.
Graphics Adapter: Onboard GFX, AGP, or PCI-Express, minimum 1024 x 768, 16-bit color
Network connection: 100Mbit Ethernet port or better.
Operating system: VMS compatible Windows based software

Network Switch (By Owner)

The Security Contractor shall coordinate switch requirements with the Owner prior to system installation. Items to coordinate shall include but not be limited to: port allocation, IP addressing, bandwidth requirements, QoS and PoE requirements.

Recording

Network Video Recorder (NVR): (By Owner)

The NVR shall provide simultaneous recording of each camera at full available resolution at full available frame rate without limitation to camera quantity, resolution, frame rate and system bandwidth.
The NVR shall provide recording for all cameras including but not limited to the following:

Resolution: up to 1920x1080
Frame rate: up to 30 frames per second
Video compression: JPEG / MPEG-4 / H.264
Video Stream Bandwidth: up to 5 Mbps
Motion detection: up to 24 hours occupancy with 100% activity

The NVR shall provide authentication of video where the video is watermarked with an authentication key/signature during recording of live video to a hard drive. Authentication shall be present on all recordings and shall include but not be limited to the following:

The video player shall have the ability to verify the authenticity during playback.
Authentication shall provide the recorder name, camera name, video time and user information.
The authentication shall have the ability to be password protected.
Authenticated recording shall be transferable to video compact discs, digital video discs and USB thumb drives.

Video Management System (VMS) Recording Software

The Recording software shall be at an enterprise level consisting of:

- Multiple sever capabilities
- Multiple site capabilities
- Multiple camera license capabilities

The software shall provide digital recording capabilities of cameras with both simultaneous recording of audio and video.
The software shall provide administration configuration capabilities to authorized personnel via the facility's data network.
The software shall have capabilities of simultaneous live audio / video monitoring, playback of recorded audio / video events and audio / video archiving to Directly Attached Storage (DAS), Storage Area Network (SAN) or Network Attached Storage (NAS) device without performance degradation of any one process.
The software shall have the following operating capabilities:

- Ability to search through motion, event, thumbnail, transaction, alarm events.
- Ability to integrate video analytics in a simple and easy-to-use interface.
- Alarm and motion event-based recording:
  - Motion mapping and masking
  - Resolution adjustment
  - Record rate adjustment
  - Pre / post recording

2.3 WIRE AND CABLE

This equipment shall at a minimum conform to the following specifications. Cable conductor and gauge requirements may vary depending on device requirements. The Security Contractor to determine and utilize cables with proper conductor and gauge requirements to provide optimum operation of system devices.

Refer to the associated Equipment Schedule on the Technology Construction Drawings for all wire and cable requirements.

Video Surveillance Cabling outer sheath shall be coordinated with Owner

PART 3 - EXECUTION

3.1 GENERAL

The Security Contractor shall closely coordinate with the Owner to ensure that Owner provided equipment is procured, configured (as necessary), and installed (as necessary) with ample lead time prior to the Contractor's use of the equipment.

The Security Contractor shall coordinate closely with the Owner to gather all network related information required to install the Video Surveillance System. This shall include but not be limited to: port allocation, IP addressing, bandwidth requirements, QoS and PoE.

Refer to Division 28 Specification Section - Security General Requirements for execution requirements.

END OF SECTION 28 20 00

SECTION 28 46 21.11

ADDRESSABLE FIRE ALARM SYSTEMS

PART 1 - GENERAL

1.0 RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.1 SUMMARY

This section includes fire alarm systems for buildings and structures. This section and the drawings outline the general, but not specific, scope of the project's fire alarm system. The successful contractor will be the Engineer of Record for the design of the system. The design and engineering of the fire alarm system shall be by the fire alarm contractor. It is the contractor's responsibility that the system meets all the requirements of NFPA and the Authority Having Jurisdiction (AHJ).

Related Requirements:

Division 01, Section "Submittal Procedures" for submitting Action, Informational, and Delegated Design Submittals.

Division 08, Section "Door Hardware" for door closers and holders with associated smoke detectors, electric door locks, and release devices that interface with the fire alarm system.

Division, 21, Section "Wet-Pipe" Sprinkler Systems" for alarm and supervisory monitoring devices associated with the fire sprinkler system.

Division 23, Section "Ductwork Accessories" for smoke and combination fire/smoke dampers with associated smoke detectors that interface with the fire alarm system.

Section 27 15 13 "Communications Copper Horizontal Cabling" for cables and conductors for fire alarm systems.

1.2 ACRONYMS

EMT: Electrical Metallic Tubing.

FACP: Fire Alarm Control Panel.

FM: FM Global

LED: Light Emitting Diode.

HLI: High Level Interface.

IMC: Intermediate Metal Conduit

NICET: National Institute for Certification in Engineering Technologies.

NRTL: Nationally Recognized Testing Laboratory.

1.3 DEFINITIONS

Definitions in NFPA 72 apply to fire alarm terms used in this Section.

1.4 SYSTEM DESCRIPTION

Noncoded, UL Listed, FM Approved, addressable system; multiplexed signal transmission dedicated to fire alarm service only with voice/strobe evacuation.

Provide system manufacturer's certification that all components provided have been tested as, and will operate as, a system.

All components provided shall be listed for use with the selected system.

Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.5 PERFORMANCE REQUIREMENTS

System shall comply with applicable codes, NFPA 72 and local amendments.

Premises protection includes a two-story Group B occupancy building.

1.6 SYSTEMS OPERATIONAL DESCRIPTION

Fire alarm signal initiation shall be by one or more of the following devices and systems:

Manual stations.

Heat detectors.

Smoke detectors.

Automatic sprinkler system water flow.

Fire alarm signal shall initiate the following actions:

Continuously operate alarm notification appliances including voice evacuation messages.

Identify alarm and specific initiating device at fire alarm control panel, connected network control panels, off-premises network control panels, and remote annunciators.

Transmit an alarm signal to the remote alarm receiving station.

De-energize electromagnetic door holders.

Unlock electric door locks in designated egress paths.

Release fire and smoke doors held open by magnetic door holders.

Activate voice/alarm communication system.

Switch heating, ventilating, and air-conditioning equipment controls to fire alarm mode.

Close smoke dampers in air ducts of designated air-conditioning duct systems.

Recall elevators to primary or alternate recall floors.

Activate elevator power shunt trip.

Activate emergency lighting control.

Activate emergency shutoffs for gas and fuel supplies.

Record events in the system memory.

Supervisory signal initiation shall be by one or more of the following devices and actions:

Valve supervisory switch.

Duct smoke detector.

Elevator shunt trip supervision.

User disabling of zones or individual devices.

Loss of communication with any panel on the network.

System trouble signal initiation shall be by one or more of the following devices and actions:

Open circuits, shorts, and grounds in designated circuits.

Opening, tampering with, or removing alarm initiating and supervisory signal-initiating devices.

Loss of communication with any addressable sensor, input module, relay, control module, remote annunciator, or Ethernet module.

Loss of primary power at the FACP.

Ground or a single break in internal circuits of the FACP.

Abnormal ac voltage at the FACP.

Break in standby battery circuitry.

Failure of battery charging.

Abnormal position of any switch at the FACP or annunciator.

Voice signal amplifier failure.

System Trouble and Supervisory Signal Actions:

Activate audible and visible signals at the FACP and remote annunciators.

Identify specific device initiating the event at fire alarm control panel and remote annunciators.

After a time delay of 200 seconds, transmit a trouble or supervisory signal to the remote alarm receiving station.

Transmit system status to building management system.

1.7 ACTION SUBMITTALS

General Submittal Requirements:

Submittals shall be prepared by authorized equipment dealers, vendors, suppliers, or representative of the products submitted. Include contact and business information of the equipment dealers, vendors, suppliers and representatives. Products and equipment submitted shall also be representative of the products and equipment to be procured and installed. General product data and shop drawings downloaded from unaffiliated websites will not be reviewed or accepted.

The Engineer shall be given a submittal review time of ten (10) working days upon receipt of submittal. Previous submittal rejection or revision shall not compress this review time. It shall be the contractor's responsibility to ensure these review and/or re-review times are incorporated into the submittal schedule with enough lead time as not to affect overall construction schedule.

After review, submittals shall be returned together with review comments and specific actions (if required) to be taken by the Contractor. Typical comments and actions will be:

Reviewed – resubmittal not required.
Rejected – resubmittal required.
Revise and Resubmit – resubmittal required.
Make Corrections as Noted – resubmittal not required unless corrections cannot be met.

Product data and shop drawing submittals shall be submitted in conjunction with one another. Submittals that are received individually will be returned without review until both are received.

Submittals shall be approved by the Consultant prior to submitting them to the AHJ for permit.

If more than one (1) re-submittals (either for shop drawings or for as-built drawings) are made by the Contractor, the Owner reserves the right to charge the Contractor for subsequent reviews by their consultants. Such extra fees shall be deducted from payments by the Owner to the Contractor.

Shop Drawings shall be prepared by persons with the following qualifications:

Trained and certified by manufacturer in fire alarm system design.
NICET certified, fire alarm technician; Level IV minimum or a Professional Engineer registered in the State of Montana and familiar with this type of installation.

Shop drawings shall be signed by NICET technician or signed and stamped by a Professional engineer registered in the State of Montana at the time of submittal to the Consultant.

Product Data: For each type of product, including furnished options and accessories.

Include construction details, material descriptions, dimensions, profiles, and finishes.

Include rated capacities, operating characteristics, and electrical characteristics.

Shop Drawings: For fire alarm system.

Comply with recommendations and requirements in Chapter 7, "Documentation" and Chapter 10, "Fundamentals" in NFPA 72.

System Operation Description: Include a detailed description for the project, including method of operation and supervision of each type of circuit and sequence of operations for manually and automatically initiated system inputs and outputs. Manufacturer's standard descriptions for generic systems are not acceptable.

Device Address List: Coordinate with final system programming.

System Riser Diagram: Include a detailed riser diagram with device addresses, conduit sizes, cable and wire types and sizes. Include type and number of system components on each circuit.

Include plans, elevations, sections, details, and attachments to other work.

Floor Pans: Include floor plans that indicate the use of all rooms; locations of alarm initiating devices, locations of alarm notification appliances and locations of fire alarm control panel, annunciators, transponders and notification power supplies.

Include a graphic map adjacent to each fire alarm control panel and remote annunciator. Graphic maps shall be correctly oriented for their installed location. Graphic maps shall be approved by the Owner and AHJ prior to installation.

Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring. Show wiring color code.

Visible Notification Appliances: Include candela ratings for visible alarm notification appliances.

Audible Notification Appliances: Include sound level ratings for audible alarm notification appliances.

Detail assembly and support requirements.

Include voltage drop calculations for notification appliance circuits.

Include battery-size calculations.

Include input/output matrix.

Include statement from manufacturer that all equipment and components have been tested as a system and meet all requirements in this Specification and in NFPA 72.

Include performance parameters and installation details for each detector.

Verify that each duct smoke detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.

Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale; coordinate location of duct smoke detectors and access to them.

Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators.
Show field wiring required for HVAC unit shutdown on alarm.
Locate detectors according to manufacturer's written recommendations.

Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.

Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits and point-to-point wiring diagrams.

1.8 REQUESTS FOR INFORMATION

All “Requests for Information” submitted by the Contractor shall include a proposed solution and an estimated cost/schedule impact. Any RFI’s that do not contain this required information will be sent back to the Contractor unanswered.

Schedule the work to provide the Engineer a minimum review time of five (5) business days upon receipt of RFIs to provide a response.

1.9 INFORMATIONAL SUBMITTALS

Qualification Data: For Installer.

Field quality-control reports.

1.10 Sample Warranty: For special warranty.

1.11 CLOSEOUT SUBMITTALS

Operation and Maintenance Data: For fire alarm systems and components to include in emergency, operation, and maintenance manuals.

In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:

Comply with the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
As-Built drawings shall be provided in PDF and AutoCAD format.
Provide "Fire Alarm and Emergency Communications System Record of Completion Documents" according to the "Completion Documentation" section in Chapter 7, "Fundamentals", in NFPA 72.
Complete wiring diagrams showing connections between all devices and equipment. Each conductor shall be numbered at every junction point with indication of origination and termination points.
Riser diagram.
Device addresses.
Record copy of site-specific software.
Provide "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:

Equipment tested.
Frequency of testing of installed components.
Frequency of inspection of installed components.
Requirements and recommendations related to results of maintenance.
Manufacturer's user training manuals.

Manufacturer's required maintenance related to system warranty requirements.
Abbreviated operating instructions for mounting at fire alarm control panel and each annunciator unit.
Installation instructions for each device installed.

1.12 MAINTENANCE MATERIAL SUBMITTALS

Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.

Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.

Smoke Detectors, Heat Detectors, Fire Detectors: Quantity equal to 10 percent of amount of each type installed, but no fewer than one unit of each type.

Detector Bases: Quantity equal to two percent of amount of each type installed, but no fewer than one unit of each type.

Manual Pull Stations: Quantity equal to 10 percent of amount installed, but no fewer than one unit.

Relay Modules, Monitor Modules, Control Modules, Isolation Modules: Quantity equal to 10 percent of amount of each type installed, but no fewer than on unit of each type.

Keys and Tools: One extra set for access to locked or tamperproofed components.

Audible and Visual Notification Appliances: One of each type installed.

Fuses: Two of each type installed in the system. Provide in a box or cabinet with compartments marked with fuse types and sizes.

1.13 QUALITY ASSURANCE

Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.

Installer Qualifications: Installation shall be by personnel certified by NICET as fire alarm Level II or higher technician.

NFPA Certification: Obtain certification according to NFPA 72 by an NRTL.

1.14 PROJECT CONDITIONS

Use of Devices during Construction: Protect devices during construction unless devices are placed in service to protect the facility during construction.

1.15 WARRANTY

Special Warranty: Manufacturer agrees to repair or replace fire alarm system equipment and components that fail in materials or workmanship within specified warranty period.

Warranty Extent: All equipment and components not covered in the Maintenance Service Agreement.

Warranty Period: One year from date of Substantial Completion.

As-built: Drawings shall be maintained by the awarded contractor for the duration of the warranty period to ensure complete system accuracy.

PART 2 - PRODUCTS

2.0 MANUFACTURERS

Manufacturers: Subject to compliance with requirements, provide products by one of the following:

Fire Alarm Control Panel:

Bosch Security Systems, Inc.
Edwards United Technologies
Fike Corporation
Fire-Lite Alarms, Inc.; a Honeywell Company.
Gamewell - FCI by Honeywell.
Johnson Controls
Mircom Technologies, Ltd.
Notifier
Potter Electric Signal Company, LLC.
Siemens Industry, Inc.; Fire Safety Division.
SilentKnight; a Honeywell Company.
Engineer approved equivalent. Approval shall be obtained prior to project bid.

Fire Alarm Wire and Cable:

Comtran Corporation.
Helix/HiTemp Cables, Inc.; a Draka USA Company.
West Penn Wire/CDT; a division of Cable Design Technologies.
Engineer approved equivalent. Approval shall be obtained prior to project bid.

Equipment

Proprietary equipment by FACP Manufacturer; or
Fenwal Controls
Keltron Corporation.
Protectowire Company, Inc.

Audible and Visual Signals:

Proprietary equipment by FACP Manufacturer; or
Commercial Products Group.
Federal Signal Corporation.
Gentex Corporation.
System Sensor.
Wheelock; a Brand of Eaton
Engineer approved equivalent. Approval shall be obtained prior to project bid.

2.1 FIRE ALARM CONTROL PANEL

General Requirements for Fire Alarm Control Panel:

Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864 and listed and labeled by an NRTL.

System software and programs shall be held in nonvolatile flash, electrically erasable, programmable, read-only memory, retaining the information through failure of primary and secondary power supplies.
Include a real-time clock for time annotation of events on the event recorder.

Provide communication between the FACP and remote circuit interface panels, annunciators, and displays.
The FACP shall be listed for connection to a central station signaling system service.
Provide nonvolatile memory for system database, logic, and operating system and event history. The system shall require no manual input to initialize in the event of a complete power down condition. The FACP shall provide a minimum 500-event history log.

The FACP shall indicate which communication zones have been silenced and shall provide selective silencing of alarm notification appliances by building communication zone.

Addressable control circuits for operation of notification appliances and mechanical equipment: The FACP shall be listed for releasing service.

Alphanumeric Display and System Controls: Arranged for interface between human operator at fire alarm control panel and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

Annunciator and Display: Liquid-crystal type, three line(s) of 80 characters, minimum.

Keypad: Arranged to permit entry and execution of programming, display, and control commands.

Initiating Device, Notification Appliance, and Signaling Line Circuits:

Pathway Class Designations: NFPA 72, Class B.

Pathway Survivability: Level 0.

Install no more than 256 addressable devices on each signaling-line circuit.

Serial Interfaces:

One dedicated RS 485 port for remote station operation using point ID DACT.

The dial-in port shall allow remote access to the FACP for programming changes and system diagnostic routines. Access by a remote terminal shall be by encrypted password algorithm.

One RS 485 port for remote annunciators, Ethernet module, or multi-interface module (printer port).

One USB port for PC configuration.

One RS 232 port for voice evacuation interface.

Actuation of alarm notification appliances, emergency voice communications, annunciation, elevator recall, shall occur within 10 seconds after the activation of an initiating device.

Electrical monitoring for the integrity or wiring external to the FACP for mechanical equipment shutdown and magnetic door holding circuits is not required, provided a break in the circuit will cause the doors to close and mechanical equipment to shut down.

Notification Appliance Circuit:

Audible appliances shall sound in three pulse temporal pattern, as defined in NFPA 72.

Where notification appliances provide signals to sleeping areas, the alarm signal shall be a 520-Hz square wave with an intensity 15 dB above the average ambient sound level or 5 dB above the maximum sound level, or at least 75 dBA, whichever is greater, measured at the pillow.

Visual alarm appliances shall flash in synchronization where more than two appliances are in the same field of view, as defined in NFPA 72.

Elevator Shutdown: Heat detector operation in the elevator machine room or hoistway shuts down elevator power by operating a shunt trip in a circuit breaker feeding the elevator. Heat detector activation operates building notification appliances and annunciator.

Heat detectors shall be located within two feet of each sprinkler in the space and shall have a lower temperature and faster RTI as compared to the sprinkler.

Elevator Recall: Smoke detectors at the following locations shall initiate automatic elevator recall.

Elevator recall shall be initiated only by one of the following alarm initiating devices:

Elevator lobby detectors.
Smoke detector in elevator machine room.
Smoke detectors in elevator hoistway.

Elevator controller shall be programmed to move the cars to the alternate recall floor if elevator lobby detectors located on the designated recall floors are activated.

Waterflow alarm connected to sprinkler in an elevator shaft and elevator machine room shall shut down elevators associated with the location without time delay.

Waterflow switch associated with the sprinkler in the elevator pit may have a delay to allow elevators to move to the designated floor.

Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.

Voice/Alarm Signaling Service: Central emergency communication system with redundant microphones, preamplifiers, amplifiers, and tone generators provided a special module that is part of fire alarm control panel.

Indicate number of alarm channels for automatic or for manual transmission of announcements by use of the central-control microphone. Amplifiers shall comply with UL 1711.

Allow the application of, and evacuation signal to, indicated number of zones and, at the same time, allow voice paging to the other zones selectively or in any combination.
Programmable tone and message sequence selection.
Standard digitally recorded messages for "Evacuation" and "All Clear."
Generate tones to be sequenced with audio messages of type recommended by NFPA 72 and that are compatible with tone patterns of notification-appliance circuits of fire alarm control panel.

Status Annunciator: Indicate the status of various voice/alarm speaker zones.

Preamplifiers, amplifiers, and tone generators shall automatically transfer to backup units, on primary equipment failure.

Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory and digital alarm communicator transmitters shall be powered by 24-V dc source.

Alarm current draw of entire fire alarm system shall not exceed 80 percent of the power-supply module rating.

Power supply shall have a dedicated fused safety switch for this connection at the fire service entrance equipment. Paint the switch box red and identify it with “FIRE ALARM SYSTEM POWER”.

Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch. System shall have sufficient power to operate the system on standby for a period of 24 hours, followed by 15 minutes of alarm.

Batteries: Sealed lead calcium.

Battery and Charger Capacity: Comply with NFPA 72.

Surge Protection: Install surge protection on normal as power for the FACP and its accessories. Comply with Division 26 Section “Transient-Voltage Suppression for Low-Voltage Electrical Power Circuits” for auxiliary suppressors.

Alarm Silencing, Trouble and Supervisory Alarm Reset: Manual reset at the FACP and remote annunciators after initiating devices are restored to normal.

Silencing switch operation halts alarm operation of notification appliances and activates an “alarm silence” light. Display of identity of the alarm zone or device is retained.

Audible and visual notification appliances shall both stop upon activation of the silencing switch.

Subsequent alarm signals from other devices or zones reactivate notification appliances until the silencing switch is operated again.

Walk Test: A test mode to allow one person to test alarm and supervisory features of initiating devices. Enabling of this mode shall require entry of a password. The FACP and annunciators shall display a test indication while the test is underway. If testing ceases while in walk test mode, after a preset delay, the system shall automatically return to normal.

Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.2 MANUAL FIRE ALARM BOXES

General Requirements for Manual Fire alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.

Double-action mechanism requiring two actions to initiate and alarm, pull lever type; with integral addressable module arranged to communicate manual station status (normal, alarm, or trouble) to fire alarm control panel

Station Reset: Key- or wrench-operated switch.

2.3 SYSTEM SMOKE DETECTORS

General Requirements for System Smoke Detectors:

Comply with UL 268; operating at 24 Vdc, nominal.

Detectors shall be two wire type.

Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire alarm control panel.

Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.

Latching: Detectors latch in the off-normal state and require manual reset of the system to restore them to normal.

Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.

Photoelectric Smoke Detectors:

Detector address shall be accessible from fire alarm control panel and shall be able to identify the detector's location within the system and its sensitivity setting.

An operator at fire alarm control panel, having the designated access level, shall be able to manually access the following for each detector:

Primary status.
Device type.
Present average value.
Present sensitivity selected.
Sensor range (normal, dirty, etc.).

Duct Smoke Detectors: Photoelectric type complying with UL 268A.

Detector address shall be accessible from fire alarm control panel and shall be able to identify the detector's location within the system and its sensitivity setting.

An operator at fire alarm control panel, having the designated access level, shall be able to manually access the following for each detector:

Primary status.
Device type.
Present average value.
Present sensitivity selected.
Sensor range (normal, dirty, etc.).

Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector for smoke detection in HVAC system ducts.

Each sensor shall have multiple levels of detection sensitivity.

Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.

Relay Fan Shutdown: Fully programmable relay rated to interrupt fan motor-control circuit.

Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.

Integral Visual-Indicating Light: LED type. Indicating detector has operated and power on status. Provide remote status and alarm indicator and test station; coordinate location with Owner and Architect prior to installation.

2.4 HEAT DETECTORS

General Requirements for Heat Detectors: Comply with UL 521.

Temperature sensors shall test for and communicate the sensitivity range of the device.

Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F or a rate of rise that exceeds 15 deg F per minute unless otherwise indicated.

Mounting: Twist-lock base interchangeable with smoke detector bases.

Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire alarm control panel.

Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of 135 deg F.

Mounting: Twist-lock base interchangeable with smoke detector bases.

Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire alarm control panel.

2.5 NOTIFICATION APPLIANCES

General Requirements for Notification Appliances: Connected to notification-appliance signal circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for system connections.

Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.

Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet from the horn, using the coded signal prescribed in UL 464 test protocol.

Visible Notification Appliances: Xenon strobe lights complying with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word “ALERT” is engraved in minimum 1-inch-high letters on the lens.

Rated Light Output: As indicated on design drawings.

15/30/75/110 cd, selectable in the field.
135/150/177/185 cd, selectable in the field.

Mounting: Wall mounted unless otherwise indicated.

For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.

Flashing shall be in a temporal pattern, synchronized with other units.

Strobe Leads: Factory connected to screw terminals.

Mounting Faceplate: Factory finished, white.

Voice/Tone Notification Appliances:

Comply with UL 1480.

Speakers for Voice Notification: Locate speakers for voice notification to provide the intelligibility requirements of the "Notification Appliances" and "Emergency Communications Systems" chapters in NFPA 72.

High-Range Units: Rated 2 to 15 W.

Low-Range Units: Rated 1 to 2 W.

Mounting: Flush

Matching Transformers: Tap range matched to acoustical environment of speaker location.

2.6 MAGNETIC DOOR HOLDERS

Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.

Electromagnets: Require no more than 3 W to develop 25-lbf holding force.

Wall-Mounted Units: Flush mounted unless otherwise indicated.

Rating: 24-V ac or dc, or

Rating: 120-V ac

Material and Finish: Match door hardware.

2.7 REMOTE ANNUNCIATOR

Description: Annunciator functions shall match those of fire alarm control panel for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire alarm control panel, including acknowledging, silencing, resetting, and testing.

Mounting: Flush cabinet, NEMA 250, Type 1.

Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire alarm control panel. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

2.8 ADDRESSABLE INTERFACE DEVICE

General:

Include address-setting means on the module.

Store an internal identifying code for control panel use to identify the module type.

Listed for controlling HVAC fan motor controllers.

Monitor Module: Microelectronic module providing a system address for alarm initiating devices for wired applications with normally open contacts.

Integral Relay: Capable of providing a direct signal to elevator controller to initiate elevator recall and to circuit-breaker shunt trip for power shutdown.

Allow the control panel to switch the relay contacts on command.

Have a minimum of two normally open and two normally closed contacts available for field wiring.

Control Module:

Operate notification devices.

Operate solenoids for use in sprinkler service.

2.9 DIGITAL ALARM COMMUNICATOR TRANSMITTER

Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632 and listed and labeled by an NRTL.

Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire alarm control panel and automatically capture two telephone line(s) and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on either line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.

Local functions and display at the digital alarm communicator transmitter shall include the following:

Verification that both telephone lines are available.

Programming device.

LED display.

Manual test report function and manual transmission clear indication.

Communications failure with the central station or fire alarm control panel.

Digital data transmission shall include the following:

Address of the alarm initiating device.

Address of the supervisory signal.

Address of the trouble-initiating device.

Loss of ac supply.

Loss of power.

Low battery.

Abnormal test signal.

Communication bus failure.

Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

2.10 RADIO ALARM TRANSMITTER

Transmitter shall comply with NFPA 1221 and 47 CFR 90.

Description: Manufacturer's standard commercial product; factory assembled, wired, and tested; ready for installation and operation.

Packaging: A single, modular, NEMA 250, Type 1 metal enclosure with a tamper-resistant flush tumbler lock.

Signal Transmission Mode and Frequency: VHF or UHF 2-W power output, coordinated with operating characteristics of the established remote central receiving station designated by Owner.

Normal Power Input: 120-V ac.

Secondary Power: Integral-sealed, rechargeable, 12-V battery and charger. Comply with NFPA 72 requirements for battery capacity; submit calculations.

Antenna: Omnidirectional, coaxial half-wave, dipole type with driving point impedance matched to transmitter and antenna cable output impedance. Mount to building structure where indicated. Wind-load strength of antenna and mounting hardware and supports shall withstand 100 mph with a gust factor of 1.3 without failure.

Antenna Cable: Coaxial cable with impedance matched to the transmitter output impedance.

Antenna-Cable Connectors: Weatherproof.

Alarm Interface Devices: Circuit boards, modules, and other auxiliary devices, integral to the transmitter, matching fire alarm and other system outputs to message-generating inputs of the transmitter that produce required message transmissions.

Functional Performance: Unit shall receive alarm, supervisory, or trouble signal from fire alarm control panel or from its own internal sensors or controls and shall automatically transmit signal along with a unique code that identifies the transmitting station to the remote central receiving station. Transmitted messages shall correspond to standard designations for fire-reporting system to which the signal is being transmitted and shall include separately designated messages in response to the following events or conditions:

Transmitter Low-Battery Condition: Sent when battery voltage is below 85 percent of rated value.

System Test Message: Initiated manually by a test switch within the transmitter cabinet, or automatically at an optionally preselected time, once every 24 hours, with transmission time controlled by a programmed timing device integral to transmitter controls.

Transmitter Trouble Message: Actuated by failure, in excess of one-minute duration, of the transmitter normal power source, derangement of the wiring of the transmitter, or any alarm input interface circuit or device connected to it.

Local Fire Alarm System Trouble Message: Initiated by events or conditions that cause a trouble signal to be indicated on the building system.

Local Fire Alarm System Alarm Message: Actuated when the building system goes into an alarm state. Identifies device that initiated the alarm.

Local Fire Alarm System, Supervisory-Alarm Message: Actuated when the building alarm system indicates a supervisory alarm

PART 3 - EXECUTION

3.0 EXAMINATION

Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.

Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed before installation begins.

Examine rough in for electrical connections to verify actual locations of connections before installation.

Proceed with installation only after unsatisfactory conditions have been corrected.

3.1 EQUIPMENT INSTALLATION

Comply with currently adopted version of NFPA 72, and requirements of the authorities having jurisdiction for installation and testing of fire alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."

Devices placed in service before all other trades have completed cleanup shall be replaced.

Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.

Install wall-mounted equipment, with tops of cabinets not more than 78 inches above the finished floor.

Manual Fire alarm Boxes:

Install manual fire alarm box in the normal path of egress within 60 inches of the exit doorway.

Mount manual fire alarm box on a background of a contrasting color.

The operable part of manual fire alarm box shall be between 42 inches and 48 inches above floor level. All devices shall be mounted at the same height unless otherwise indicated.

Smoke or Heat Detector Spacing:

Comply with the "Smoke Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for smoke detector spacing.

Comply with the "Heat Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for heat-detector spacing.

Smooth ceiling spacing shall not exceed the rating of the detector.

Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Annex A or Annex B in NFPA 72.

HVAC: Locate detectors not closer than 36 inches from air-supply diffuser or return-air opening.

Lighting Fixtures: Locate detectors not closer than 12 inches from any part of a lighting fixture and not directly above pendant mounted or indirect lighting.

Install a cover on each smoke detector that is not placed in service during construction. Cover shall remain in place except during system testing. Remove cover prior to system turnover. Shipping covers are not listed for protection against contamination during construction.

Duct Smoke Detectors: Comply with NFPA 72. Install sampling tubes so they extend the full width of duct. Tubes more than 36 inches long shall be supported at both ends.

Do not install smoke detector in duct smoke detector housing during construction. Install detector only during system testing and prior to system turnover.

Elevator Shafts: Coordinate heat detector temperature rating and location with sprinkler rating and location.

Remote Status and Alarm Indicators: Install in a visible location near each smoke detector, sprinkler waterflow switch, and valve-tamper switch that is not readily visible from normal viewing position.

Audible Alarm-Indicating Devices: Install not less than 6 inches below the ceiling. Install audible notification appliances on flush-mounted back boxes with the device-operating mechanism concealed behind a grille. Install all devices at the same height unless otherwise indicated.

Visible Alarm-Indicating Devices: Install visible notification appliance adjacent to each audible notification appliance such that the entire lens is between 80 inches and 96 inches and at least 6 inches below the ceiling. Install all devices at the same height unless otherwise indicated.

Device Location-Indicating Lights: Locate in public space near the device they monitor.

3.2 WIRING INSTALLATION

Wire and cable for fire alarm systems shall be UL listed and labeled as complying with NFPA 70, Article 760.

Wire size shall be as recommended by the fire alarm system manufacturer.

Pathways above recessed ceilings and in accessible locations may be routed exposed.

All exposed pathways shall be installed in EMT.

Fire alarm circuits and equipment control wiring associated with the fire alarm system shall be installed in a dedicated raceway system. This system shall not be used for any other wire or cable.

Open cabling shall be installed in a neat and workmanlike manner and shall be run perpendicular or parallel to building structural members. Diagonal routing of cable shall not be considered acceptable and shall cause to be removed and reinstalled.

Open cabling shall be routed away from other building cabling and equipment and shall be routed to and from the device in a vertical or horizontal manner. Maintain cabling at the same level where possible, Cabling that is not dropped vertically to the device or routed horizontally straight to the device shall not be considered acceptable. Cabling that is routed through, over, under or around other equipment, when a straight horizontal or vertical path is available shall not be considered acceptable and shall cause the cable to be removed and be reinstalled.

Open cabling shall be supported at a minimum of every 4 to 6 feet to building structural members utilizing metal bridle rings. Cabling that is secured to sprinkler piping, HVAC ductwork, electrical conduit or other non-structural building member shall not be acceptable and shall cause the cable to be re-installed and re-supported in a proper manner.

Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by the manufacturer. Install conductors parallel with or at right angles to sides and back of enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system’s wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure type terminal blocks or plug connectors.

Color Coding: Color code fire alarm conductors differently from the normal building power wiring. Use one color for alarm circuit wire and a different color code for supervisory circuits. Color code audible alarm indicating circuits differently from alarm initiating circuits. Use different colors for visible alarm indicating devices. Coordinate with Owner for standard color coding

Paint fire alarm system junction boxes and covers red.

3.3 CONNECTIONS

For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Section 08 71 00 "Door Hardware." Connect hardware and devices to fire alarm system.

Verify that hardware and devices are listed for use with installed fire alarm system before making connections.

Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 36 inches from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.

Alarm initiating connection to smoke control system (smoke management) at firefighters' smoke control system panel.

Alarm initiating connection to stairwell and elevator-shaft pressurization systems.

Smoke dampers in air ducts of designated HVAC duct systems.

Magnetically held-open doors.

Electronically locked doors and access gates.

Alarm initiating connection to elevator recall system and components.

Alarm initiating connection to activate emergency lighting control.

Alarm initiating connection to activate emergency shutoffs for gas and fuel supplies.

Supervisory connections at valve supervisory switches.

Supervisory connections at elevator shunt-trip breaker.

Data communication circuits for connection to building management system.

3.4 IDENTIFICATION

Identify system components, wiring, cabling, and terminals.

Install framed instructions in a location visible from fire alarm control panel.

3.5 GROUNDING

Ground fire alarm control panel and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire alarm control panel.

Ground shielded cables at the control panel location only. Insulate shield at device location.

3.6 FIELD QUALITY CONTROL

Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

Perform tests and inspections.

Perform the following tests and inspections with the assistance of a factory-authorized service representative:

Visual Inspection: Conduct visual inspection prior to testing.

> Inspection shall be based on completed record Drawings and system documentation that is required by NFPA 72.
> Comply with the "Visual Inspection Frequencies" table in the "Inspection" section of Chapter 14, "Inspection, Testing and Maintenance", in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.

System Testing: Comply with the "Test Methods" table in the "Testing" section of Chapter 14, "Inspection, Testing and Maintenance", in NFPA 72.

Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.

Test visible appliances for the public operating mode according to manufacturer's written instructions.

Detectors that are outside of their marked sensitivity range shall be replaced.

Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" and the "Inspection and Testing Form" located in NFPA 72.

Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.

Fire alarm system will be considered defective if it does not pass tests and inspections.

Prepare test and inspection reports.

3.7 SOFTWARE SERVICE AGREEMENT

Comply with UL 864.

Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

Upgrade Notice: At least 30 days to allow Owner to schedule access to system and to upgrade computer equipment if necessary.

3.8 DEMONSTRATION

Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire alarm system.

END OF SECTION 28 46 21.11