DLR Group

Architecture
Planning
Interiors

Fern Ridge Middle School

Fern Ridge School District
Elmira, Oregon

Project Manual Volume 1 of 2

Contract Documents Bid Set

DLR Group Project No. 74-13107-30

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SPECIFICATIONS: VOLUME 1

SECTION 220500 - COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The provisions of This Section, Common Work Results for Plumbing, apply to all sections in Division 22.

C. All Sections of Division 22 are interrelated. When interpreting any direction, material, and method specified in any section of Division 22 consider it within the entirety of Work in Division 22.

1.2 SUMMARY

A. The intent of Division 22 Specifications and the accompanying Drawings is to provide a complete and workable facility with complete systems as shown, specified and required by applicable codes. Include all work specified in Division 22 and shown on the accompanying Drawings, including appurtenances, connections, etc., in the finished job.

B. The Division 22 Specifications and the accompanying Drawings are complementary and what is called for by one shall be as binding as if called for by both. Items shown on the Drawings are not necessarily included in the Specifications and vice versa. Specifications shall supersede drawings in case of conflict.

C. Imperative language is frequently used in Division 22 Specifications. Except as otherwise specified, requirements expressed imperatively are to be performed by the Contractor.

D. The Drawings that accompany the Division 22 Specifications are diagrammatic. They do not show every offset, bend, tee, or elbow which may be required to install work in the space provided and avoid conflicts. Offsets and transitions shall be assumed at a minimum at each duct crossing, structural penetrations through shear walls or beams, structural grids where ceiling heights are restricted, and at piping mains. Follow the Drawing as closely as is practical to do so and install additional bends, offsets and elbows where required by local conditions from measurements taken at the Building, subject to approval, and without additional cost to the Owner. The right is reserved to make any reasonable changes in fixture location prior to roughing-in, without cost impact.

1.3 RELATED WORK

A. The General and Supplemental Conditions apply to this Division, including but not limited to:

1. Drawings and specifications.
2. Public ordinances, permits.
3. Include payments and fees required by governing authorities for work of this Division.

B. Division 1, General Requirements, applies to this Division.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements:

1. All products and equipment shall comply with Oregon Revised Statute (ORS) 453.005(7)(e) prohibiting pentabrominated, octabrominated and decabrominated diphenyl ethers. Where products or equipment within this specification contain these banned substances, provide complying products and equipment from approved manufacturers with equal performance characteristics.
2. General: All work and materials shall conform to the local and State codes, and all Federal, State and other applicable laws and regulations.
3. Contractor responsible for obtaining and payment for all permits, licenses, and inspection certificates required in accordance with provisions of Contract Documents.

B. Materials and equipment shall be new. Work shall be of good quality, free of faults and defects and in conformance with the Contract Documents.

C. Apparatus shall be built and installed to deliver its full rated capacity at the efficiency for which it was designed.

D. The entire plumbing system and apparatus shall operate at full capacity without objectionable noise or vibration.

E. All equipment shall be installed level and true. Housekeeping pads and curbs shall account for floor or roof slope.

F. Materials and Equipment:

1. Each piece of equipment furnished shall meet all detailed requirements of the Drawings and Specifications and shall be suitable for the installation shown. Equipment not meeting all requirements will not be acceptable, even though specified by name along with other manufacturers.
2. Where two or more units of the same class of equipment are furnished, use products of the same manufacturer. Component parts of the entire system need not be products of same manufacturer.
3. Furnish all materials and equipment of size, make, type, and quality herein specified.

4. Equipment scheduled by performance or model number shall be considered the basis of the design. If other specified manufacturer's equipment is provided in lieu of the basis of design equipment the contractor is responsible for all changes and costs which may be necessary to accommodate this equipment, including different sizes and locations for connections, different electrical characteristics, different dimensions, different access requirements or any other differences which impact the project.

G. Workmanship:

1. General: All materials shall be installed in a neat and professional manner.
2. Manufacturer’s Instructions: Follow manufacturer’s directions where they cover points not specifically indicated. If they are in conflict with the Drawings and Division 22 Specifications, obtain clarification before starting work.

H. Cutting and Patching:

1. Cutting, patching, and repairing for the proper installation and completion of the work specified in this Division including plastering, masonry work, concrete work, carpentry work, and painting shall be performed by skilled craftsmen of each respective trade in conformance with the appropriate Division of Work.
2. Additional openings required in building construction shall be made by drilling or cutting. Use of jackhammer is specifically prohibited.
3. Fill holes which are cut oversize so that a tight fit is obtained around the sleeves passing through.
4. Beams or columns shall not be pierced without permission of Architect and then only as directed.
5. All new or existing work cut or damaged shall be restored to its original condition. Where alterations disturb lawns, paving, walks, etc., the surfaces shall be repaired, refinished, and left in condition existing prior to commencement of work.

1.5 SUBMITTALS

A. Shop Drawings:

1. The Contract Drawings indicate the general layout of the piping, and various items of equipment. Coordination with other trades and with field conditions will be required. For this purpose, prepare Shop Drawings of all piping, and equipment installations. Shop Drawings shall be new drawings prepared by Contractor and not reproductions or tracings of Architect’s Drawings. Overlay drawings with shop drawings of other trades and check for conflicts. All drawings shall be same size as Architect’s Drawings with title block similar to Contract Drawings and identifying Architect’s Drawing number or any reference drawings. All drawings shall be fully dimensioned including both plan and elevation dimensions. Shop drawings cannot be used to make scope changes.
2. Shop drawings shall be prepared in two-dimensional format.

3. Shop drawings shall include but are not limited to:

    a. Plumbing site plan drawn to same scale as Site Plan.
    b. Complete floor plans with plumbing to a minimum of 1/4-inch equals 1'-0" scale.
    c. Plumbing in mechanical rooms to a minimum of 1/2-inch equal 1'-0" scale.
    d. Sections of congested areas to a minimum of 1/2-inch = 1'-0" scale.
    e. Fabricated Equipment: Scale and drawing sizes to suit contractor except equipment shall not be less than 1/2-inch equals 1'-0" scale.

4. Submit shop drawings for review prior to beginning fabrication. Additional shop drawings may be requested when it appears that coordination issues are not being resolved in the field or when there is a question as to whether contract documents are being complied with or the design intent is being met.

B. Product Data:

1. In general, submit product data for review on all scheduled pieces of equipment, on all equipment requiring electrical connections or connections by other trades, and as required by each specification section or by Drawing notes. Include manufacturer's detailed shop drawings, specifications and data sheets. Data sheets shall include capacities, RPM, BHP, pressure drop, design and operating pressures, temperatures, and similar data. Manufacturer's abbreviations or codes are not acceptable.
2. List the name of the motor manufacturer and service factor for each piece of equipment.
3. Indicate equipment operating weights including bases and weight distribution at support points.
4. In the case of equipment such as wiring devices, time switches, valves, etc., specified by specific catalog number, a statement of conformance will suffice.

C. Submission Requirements:

1. Shop Drawings and Product Data:

    a. Refer to Division 1 for additional requirements related to submittals.
    b. Submit copies of shop drawings and product data for Work of Division 22 in a 3-ring loose leaf binder with each item filed under a tab and labeled with its respective specification section number, article and paragraph, and mark if applicable.
    c. Submit electronic copies of shop drawings and product data for Work of Division 22 in PDF format with each item filed under a folder and labeled with its respective specification section number, article, and paragraph and mark, if applicable.
    d. Include a complete index in the original submittal. Indicate both original items submitted and note stragglers that will be submitted at a later date to avoid delay in submitting.
    e. The bulk of the shop drawings and product data shall be included with the original submittal.

D. Contractor Responsibilities: It shall be the Contractor's responsibility to:

1. See that all submittals are submitted at one time and are in proper order.
2. Ensure that all equipment will fit in the space provided.
3. Assure that all deviations from Drawings and Specifications are specifically noted in the submittals. Failure to comply will void review automatically.

1.6 OPERATING AND MAINTENANCE MANUAL, PARTS LISTS, AND OWNERS INSTRUCTIONS

A. Refer to Division 1 for additional requirements.

B. Submit three bound copies of manufacturer's operation and maintenance instruction manuals and parts lists for each piece of equipment or item requiring servicing. Literature shall be on 8-1/2"x11" sheets or catalogs suitable for side binding. Submit data when the work is substantially complete, packaged separately, and clearly identified in durable 3-ring binder. Include name and contact information for location of source parts and service for each piece of equipment. Clearly mark and label in each submittal, the piece of equipment provided with the proper nameplate and model number identified. Provide wiring diagrams for all electrically powered equipment.

C. Instruct Owner thoroughly in proper operation of equipment and systems, in accordance with manufacturer's instruction manuals. Operating instructions shall cover all phases of control.

1.7 PROJECT CONDITIONS

A. Existing Conditions: Prior to bidding, verify and become familiar with all existing conditions by visiting the site, and include all factors which may affect the execution of this Work. Include all related costs in the initial bid proposal.

B. Coordinate exact requirements governed by actual job conditions. Check all information and report any discrepancies before fabricating work. Report changes in time to avoid unnecessary work.

C. Coordinate shutdown and start-up of existing, temporary, and new systems and utilities. Notify Owner, City and Utility Company.

1.8 WARRANTY

A. Provide a written guaranty covering the work of this Division (for a period of one calendar year from the date of acceptance by the Owner) as required by the General Conditions.

B. Provide manufacturer's written warranties for material and equipment furnished under this Division insuring parts and labor for a period of one year from the date of Owner acceptance of Work of this Division.

C. Correct warranty items promptly upon notification.

1.9 PROVISIONS FOR LARGE EQUIPMENT

A. Contractor shall make provisions for the necessary openings in building to allow for admittance of all equipment.

1.10 TEST REPORTS AND CERTIFICATES

A. Contractor shall submit one copy of all test reports and certificates specified herein to the Architect.

1.11 SUBSTITUTIONS

A. Contractor shall submit any requests for product substitutions in accordance with the Instructions to Bidders and the General and Supplemental Conditions.

PART 2 - PRODUCTS

2.1 ACCESS PANELS

A. Furnish under this Division as specified in another Division of work.

2.2 PIPE SLEEVES

A. Interior Wall and Floor Sleeves: 18 gauge galvanized steel, or another pre-approved system.

B. Interior Wall and Floor Sleeves (fire rated): Fire rated and water tight system approved by Authority Having Jurisdiction and Owners Insurance underwriter, with rating equal to floor or wall penetration, and designed specifically for the floor or wall construction, piping material, size and service.

C. Exterior Wall Sleeves: Cast iron.

D. On Grade Floor Sleeves: Same as exterior wall sleeves.

E. Water Tight Sleeves: Combination steel pipe sleeves with water stop and anchor plate; Link Seal Model WS, mated with synthetic rubber links interlocked with bolts and nuts; Link Seal Model LS.

2.3 FLOOR, WALL AND CEILING PLATES

A. Furnish stamped split type plates as follows:

1. Floor Plates: Cast brass, chromium plated.
2. Wall and Ceiling Plates: Spun aluminum.

2.4 ELECTRICAL EQUIPMENT

A. General: All equipment and installed work shall be as specified under Division 26, Electrical.

B. Coordinate with the electrical Drawings and electrical contractor for minimum electrical equipment bracing requirements based on the available interrupting current (AIC) rating at the bus of the panelboard or switchboard serving the piece of equipment. Provide equipment that meets the bracing requirement.

C. Equipment Wiring: Interconnecting wiring within or on a piece of mechanical equipment shall be provided with the equipment unless shown otherwise. This does not include the wiring of motors, starters and controllers provided under Division 26, Electrical.

D. Control Wiring: All control wiring for plumbing equipment shall be provided herewith.

E. Codes: All electrical equipment and products shall bear the Underwriters label as required by governing codes and ordinances.

PART 3 - EXECUTION

3.1 ACCESS PANELS

A. Install in accord with manufacturer's recommendations, coordinated with architectural features.

B. Provide 2-hour fire rated doors where required bearing the U.L. label.

C. Furnish 18x18-inch panels for ceilings and for access to equipment in soffits and shafts, and 12x12-inch for walls unless indicated otherwise.

D. Furnish where indicated and where required to access valves, trap primers, shock arresters, and other appurtenances requiring operation, service or maintenance. Submit proposed locations for review prior to installation.

3.2 SLEEVES

A. Interior Floor and Wall Sleeves: Provide sleeves large enough to provide 3/4-inch clearances around pipe or ductwork. Where pipe or ductwork is insulated, insulation shall pass continuously through sleeve with 3/4-inch clearance between insulation and sleeve. Penetrations through mechanical room and fan room floors shall be made watertight by packing with safing insulation and sealing with Tremco Dymeric Sealant or approved system.

B. Sleeves Through Rated Floors and Walls: Similar to interior sleeves except install fire rated system approved by Authority Having Jurisdiction and Owners insurance underwriter, with rating equal to floor or wall penetration, and designed specifically for the floor or wall construction, piping material, size and service.

C. Exterior Wall Sleeves Below Grade: Provide water tight sleeves. Install at pipes entering building below grade and where shown. Adjust to provide positive hydrostatic seal. Contractor shall be responsible for following manufacturer's procedure for installing and tightening seal. Secure sleeves against displacement.

D. On Grade Floor Sleeves: Same as below grade exterior wall sleeves, caulked from inside.

E. Exterior Wall Sleeves Above Grade: Similar to interior wall sleeves except caulk outside with Tremco Dymeric Sealant.

F. Layout work prior to concrete forming. Do all cutting and patching required. Reinforce sleeves to prevent collapse during forming and pouring.

G. All floor sleeves shall maintain a water barrier by providing a water tight seal or they shall extend 1-inch above finished floor except through mechanical equipment room floors and shafts where sleeves shall extend 2 inches above finished floor level. Sleeves through roof shall extend 8 inches above roof. Wall sleeves shall be flush with face of wall unless otherwise indicated. Waste stacks using carriers shall have sleeves flush with floor and sealed. Sleeves through planters shall extend 8 inches above planter base.

H. Do not support pipes by resting pipe clamps on floor sleeves. Supplementary members shall be provided so pipes are floor supported.

I. Special sleeves detailed on drawings shall take precedence over this section.

3.3 CLEANING

A. General: Clean plumbing equipment, fixtures and piping of stampings and markings (except those required by codes), iron cuttings, and other refuse.

B. Painted Surfaces: Clean scratched or marred painted surfaces of rust or other foreign matter and paint with matching color industrial enamel, except as otherwise noted.

C. Additional requirements are specified under specific Sections of this Division.

3.4 EQUIPMENT PROTECTION

A. Keep pipe and conduit openings closed by means of plugs or caps to prevent the entrance of foreign matter. Protect piping, conduit, fixtures, equipment and apparatus against dirty water, chemical or mechanical damage both before and after installation. Restore damaged or contaminated fixtures, equipment, or apparatus to original conditions or replace at no cost to the Owner.

B. Protect bright finished shafts, bearing housings, and similar items until in service. No rust will be permitted.

C. Cover or otherwise suitably protect equipment and materials stored on the job site.

3.5 ACCESSIBILITY

A. General: Locate valves, thermometers, cleanout fittings and other indicating equipment or specialties requiring frequent reading, adjustments, inspection, repairs, and removal or replacement conveniently and accessibly with reference to the finished building.

B. Thermometers and Gauges: Install thermometers and gauges so as to be easily read from the floors, platforms and walkways.

3.6 FLOOR, WALL AND CEILING PLATES

A. Install on piping and ductwork passing through finished walls, floors, ceilings, partitions, and plaster furrings. Plates shall completely cover opening around pipe.

B. Secure wall and ceiling plates to pipe, insulation, or structure.

C. Plates shall not penetrate insulation vapor barriers.

D. Plates not required in mechanical rooms or unfinished spaces.

3.7 PAINTING

A. General: Coordinate painting of mechanical equipment and items with products and methods in conformance with the appropriate Division of Work, Painting. All exposed work under this division shall receive either a factory painted finish or a field prime coat finish, except:

1. Exposed copper piping.
2. Aluminum jacketed outdoor insulated piping.

B. Equipment Rooms and Finished Areas:

1. Insulation: Not painted.
2. Hangers, Uninsulated Piping, Miscellaneous Iron Work, Structural Steel Stands, Uninsulated Tanks, and Equipment Bases: Paint one coat of black enamel.
3. Steel Valve Bodies and Bonnets: One coat of black enamel.
4. Brass Valve Bodies: Not painted.
5. Equipment: One coat of grey machinery enamel. Do not paint nameplates.

C. Concealed Spaces (above ceilings, not visible):

1. Insulation: Not painted.
2. Hangers, Uninsulated Piping, Miscellaneous Iron Work, Valve Bodies and Bonnets: Not painted.

3.8 ADJUSTING AND CLEANING

A. Before operating any equipment or systems, make thorough check to determine that systems have been flushed and cleaned as required and equipment has been properly installed, lubricated, and serviced. Check factory instructions to see that installations have been made accordingly and that recommended lubricants have been used.

B. Use particular care in lubricating bearings to avoid damage by overlubrication and blowing out seals. Check equipment for damage that may have occurred during shipment, after delivery, or during installation. Repair damaged equipment as approved or replace with new equipment.

3.9 ELECTRICAL EQUIPMENT

A. Piping for plumbing systems not serving electrical space shall not be installed in any switchgear room, transformer vault, telephone room, or electric closet except as indicated.

B. Piping for plumbing systems shall not pass over switchboards or electrical panelboards. Where conflicts exist, bring to attention of Architect.

3.10 EQUIPMENT CONNECTIONS

A. Make final connections to equipment specified in sections other than Division 22 of the specifications and Owner furnished equipment in accordance with manufacturer's instructions and shop drawings furnished and as indicated.

B. Piping:

1. Connections shall include hot and cold water sanitary waste and vent.
2. Provide valves and specialties as specified and as detailed on the Drawings. Provide increasers, reducers, and any other fittings required for complete installation.
3. All piping connections shall be independently supported to prevent undue strain on equipment.

C. Refer to Specification Section 114000 Food Service Equipment for requirements.

END OF SECTION 220500

SECTION 220523 - GENERAL DUTY VALVES AND SPECIALTIES FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The provisions of Section 220500, Common Work Results for Plumbing, apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes: Valves, and balance fittings.

1.3 SUBMITTALS

A. Submit product data.

1.4 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

D. RS: Rising stem.

E. PTFE: Polytetraflouroethylene plastic.

F. SWP: Steam working pressure.

G. Lead Free: Refers to the wetted surface of pipe, fittings, and fixtures in potable water systems that have a weighted average lead content ≤0.25% per Safe Drinking Water Act as amended January 4th 2011. Section 1417 *Add specific state requirements as needed.

1.5 QUALITY ASSURANCE

A. ASME Compliance:

1. ASME B16.10 for ferrous valve dimensions.
2. ASME B31.9 for building services piping valves.

B. NSF Compliance: NSF/ANSI 61 and/or NSF/ANSI 372 for valve materials for potable-water service. Valves for domestic water must be 3rd Party Certified.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURER VALVES

A. General: Where only NIBCO INC. figure numbers are listed, equivalent products by those specified below are acceptable.

1. Balancing: Bell and Gossett, Armstrong, Tour and Anderson, and Nibco.
2. Ball: Gruvlok, Apollo, Crane, Hammond, Milwaukee and Victaulic.

B. Other Manufacturers: Submit Substitution Request.

C. All such valves shall be of one manufacturer.

D. Valve ends may be threaded, flanged, soldered, or grooved, as applicable to piping system. Refer to Section 222113 for allowable fittings.

2.2 BALL VALVES

A. Lead Free Bronze Ball: Two piece, full port, Lead Free silicon bronze body, Stainless steel or silicon bronze trim, Reinforced PTFE or TFE seats, 600 psi CWP NIBCO T/S-585-80-LF or T/S-585-66-LF.

2.3 BALANCING VALVE

A. Lead-Free Calibrated:

1. Bronze, Ametal (copper-alloy), or ductile iron body, brass globe or ball, differential pressure readout valves with integral checks, calibrated plate, integral pointer, suitable for tight shutoff, memory stops, threaded, grooved or soldered ends, 250 psi water, NSF/ANSI 61 compliant, Bell and Gossett Lead-Free Circuit Setter Plus.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide valves at connections to equipment where shown or required for equipment isolation.

B. Provide separate support for valves where necessary.

3.2 APPLIED LOCATIONS PLUMBING VALVES

A. In piping 2-inches and smaller:

System	Valve Types				
	Gate	**Globe**	**Swing Check**	**Ball**	**Butterfly**
Domestic Hot	NA	NA	Lead Free Bronze	Lead Free Bronze	Not Allowed
Domestic Cold	NA	NA	Lead Free Bronze	Lead Free Bronze	Not Allowed

B. In piping 2-1/2-inches and larger:

System	Valve Types				
	Gate	**Globe**	**Swing Check**	**Ball**	**Butterfly**
Domestic Cold	NA	NA	Lead Free Iron	Not Allowed	Lead Free Ductile Iron

C. Calibrated balancing valves on domestic hot water. Size balancing valves based on the published performance curve characteristics for the scheduled flow rate for each location to ensure proper operation at design conditions.

END OF SECTION 220523

SECTION 220529 - HANGERS, SUPPORTS AND ANCHORS FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The provisions of Section 220500, Common Work Results for Plumbing apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes: Supports and anchors for piping systems and equipment.

B. Related Sections include:

1. Section 220700 Insulation for Plumbing.
2. Section 222113 Pipe and Pipe Fittings Plumbing.

1.3 SUBMITTALS

A. Submit the following:

1. Shop Drawings of contractor fabricated piping support structures.
2. No other submittals required under this section.

PART 2 - PRODUCTS

2.1 SUPPORTS, ANCHORAGE AND RESTRAINT

A. General: Provide pipe and equipment hangers and supports in accordance with the following:

1. When supports, anchorages, and seismic restraints for equipment, and supports and seismic restraints for conduit, piping, and ductwork are not shown on the Drawings, the contractor shall be responsible for their design.
2. Seismic restraints and anchorages shall resist seismic forces as specified in the latest edition of the International Building Code for the seismic zone in which the project is constructed.
3. Seismic restraint shall not introduce excessive stresses in the piping caused by thermal expansion or contraction.

4. Connections to structural framing shall not introduce twisting, torsion, or lateral bending in the framing members. Provide supplementary steel as required.
5. Seismic restraints shall be in accordance with the latest edition of the SMACNA "Seismic Restraint Manual - Guidelines for Mechanical Systems" for the Seismic Hazard Level corresponding to the seismic zone in which the project is constructed.
6. Seismic restraints shall be in accordance with the applicable code.
7. Seismic restraints shall follow the provisions described in Section 220548 Vibration and Seismic Controls for Plumbing Piping and Equipment.

B. Engineered Support Systems: The following support systems shall be designed, detailed, and bear the seal of a professional engineer registered in the State having jurisdiction.

1. Supports and seismic restraints for suspended piping and equipment.
2. Support frames such as pipe racks or stanchions for piping and equipment which provide support from below.
3. Equipment and piping support frame anchorage to supporting slab or structure.

2.2 SUPPORTS, GENERAL

A. Fabricate support members from welded standard structural shapes, pipe, and plate to carry the necessary rollers, hangers, and accessories as required. Support piping less than 4-inch pipe size from or by prefabricated roll-formed channels with necessary accessories to adequately support piping system.

B. Acceptable Manufacturers: Unistrut, Superstrut, Powerstrut and Kinline, B-Line Systems, AnvilStrut.

C. Supports and Accessories: Preformed roll-formed channels and accessories with matching compatible accessories as shown, as specified, and as required.

D. Dissimilar Metal Protection: Hydra-Zorb cushions or Cush-a-strip.

E. Clamps: Super Strut Series 700 through 702 or AnvilStrut Series 1000 through 1200.

2.3 PIPE ATTACHMENTS

A. Acceptable Manufacturers: Anvil as noted or equivalent products by Superstrut, B-Line Systems, Tolco, Michigan Hanger.

B. Uninsulated Horizontal Copper Piping:

1. 2-inch and Smaller: Anvil CT-65, CT-69, CT-99C.
2. Larger than 2-inch: Anvil 260 field or factory copper plated, plastic coated or other recognized industry methods. Electricians' tape is unacceptable.

C. Insulated Horizontal Copper Pipe with Hangers Inside of Insulation: Same as Uninsulated Horizontal Copper Pipe.

D. Insulated Horizontal Copper Pipe with Hangers Outside of Insulation:

1. 2-inch and Smaller: Anvil 65, 70, 104 or 260.
2. Larger than 2-inch: Anvil 260.

E. Other Uninsulated Horizontal Pipe:

1. 2-inch and Smaller: Anvil 65, 70, 104 or 260.
2. Larger than 2-inch: Anvil 260.

F. Other Insulated Horizontal Pipe With Hangers Inside of Insulation:

1. 2-inch and Smaller: Anvil 65, 70, 104, 260 or 300.
2. Larger than 2-inch: Anvil 260.

G. Other Insulated Horizontal Pipe with Hangers Outside of Insulation:

1. 2-inch and Smaller: Anvil 65, 70, 104 or 260.
2. Larger than 2-inch: Anvil 260.

H. Riser Clamps Copper Pipe:

1. 4-inch and Smaller: Anvil CT-121, CT-121C or 261C.
2. Larger than 4-inch: Anvil 261C.

I. Riser Clamps Other Piping: Anvil 261.

2.4 PIPE ROLLERS, INSULATION PROTECTION SHIELDS AND INSULATION PROTECTION SADDLES

A. Acceptable Manufacturers: Anvil as noted or equivalent Super Strut, B-Line Systems, Tolco, Michigan Hangers.

B. Pipe Rollers: Anvil 174 or 274 as required. Size for pipe plus insulation for insulated pipe.

C. Insulation Protection Shields: Anvil 167.

D. Insulation Protection Saddles: Anvil 160 through 166A as required. Saddles for copper pipe, factory or field copper plated.

2.5 BUILDING ATTACHMENTS

A. Acceptable Manufacturers: Anvil as listed or equivalent products by Elcen, Superstrut, B-Line Systems, Tolco, Michigan Hangers.

B. Beam Hangers:

1. On piping 6-inch and smaller: Anvil 86 with retaining clip Fig. 89.
2. On piping larger than 6-inch: Anvil 228, or 292.

C. Inserts: Anvil 152 malleable iron or 281 steel inserts. Inserts sized for required rod to support load being carried.

D. Expansion Plugs: Similar and equal to Phillips "red-head" self-drilling flush shell selected for safety factor of 4.

E. Powder actuated fasteners with silencers as approved by Architect.

PART 3 - EXECUTION

3.1 HANGERS AND SUPPORTS

A. General:

1. Install all support systems as detailed and in accordance with manufacturer's recommendations. Provide pipe racks, pipe stands, trapeze hangers, etc., as required and as detailed on the Drawings.
2. Provide adjustable hangers for all pipes complete with inserts, adjusters, bolts, nuts, swivels, all-thread rods, etc., except where specified otherwise.
3. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping and do not support piping from other piping.
4. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.
5. Install all cast iron piping in accordance with Cast Iron Soil Pipe Industry (CISPI) Standards.
6. Support all piping within 2 feet of each change of direction on both sides of fitting.

B. Insulated Piping Systems:

1. See Section 220700 for insulation requirements.
2. Insulated Piping Systems with Vapor Barrier Insulation:

    a. Install hangers outside of insulation.
    b. On piping 1-1/2-inch and larger, provide insulation protection shields at each support location.

3. Insulated Piping Systems with Non-Vapor Barrier Insulation:

    a. At the contractor's option, hangers may be installed inside or outside of insulation for piping 2-inch and smaller.

b. If hangers are installed outside of insulation, provide insulation protection shields at all support locations on piping 1-1/2-inch and larger.
c. On piping larger than 2-inch, provide insulation saddles at each support location.

C. Vertical Piping:

1. Support with U-clamps fastened to wall to hold piping away from wall unless otherwise approved.
2. Riser clamps on steel pipe to be directly welded to pipe. Riser clamps on copper pipe to be installed directly under fitting.
3. Risers that are not subject to thermal change to be supported at each floor of penetration.
4. Risers that are subject to thermal change require engineered supports. Size supports to carry all forces exerted by piping system when in operation. Riser supports shall follow the provisions described in Section 220548, Vibration and Seismic Controls for Plumbing Piping and Equipment.

D. Horizontal Piping:

1. Trapeze Hangers: Multiple pipe runs where indicated shall be supported on channels with rust resistant finish. Provide all necessary rods and supporting steel.
2. Support Spacing: Provide support at minimum spacing per MSS SP-69-1996 Pipe Hangers and Supports - Selection and Application:

a. Support piping within 2 feet of each change in direction.
b. Steel Pipe, Copper Tubing:

Minimum Pipe Size	Max. Span Steel	Max. Span Copper	Rod Size
1-inch and smaller	7 feet	5 feet	1/4-inch
1-1/4-inch to 2-inch	8 feet	8 feet	3/8-inch
2-1/2-inch to 3-inch	11 feet	9 feet	1/2-inch
4-inch to 5-inch	14 feet	12 feet	1/2-inch

c. Plumbing Piping: Support in accordance with local plumbing code.
d. Plastic Pipe: Supported a maximum of 3 feet on center for piping 1-inch and smaller and 4 feet on center for piping 1-1/4-inch and larger with rod sizes as recommended by the manufacturer.
e. Piping provided with acoustical lagging wrap shall be supported a maximum of 5 feet on center. Install hangers outside of acoustical lagging.

E. Building Attachments:

1. Fastening or attaching to steel deck (without concrete fill) is prohibited. It will be necessary to support all piping from structural members, beams, joists, or provide intermediate angle iron supporting members between joists. Supports may be attached to concrete filled steel deck with load limitations shown on the structural drawings or otherwise obtained from the structural engineer.
2. Provide horizontal bracing on all horizontal runs 1-1/2 inch and larger and exceeding 50 feet in length at 75 foot intervals and as required to provide stabilized piping systems.

3. Provide all additional structural steel angles, channels, or other members required to support piping where structures do not occur as required for proper support.
4. Arrange supports to prevent eccentric loading of joists and joist girders. Locate supports at joist panel points.

END OF SECTION 220529

SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The provisions of Section 220500, Common Work Results for Plumbing apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes: Identify piping and equipment components of the mechanical systems to indicate their function and system served.

PART 2 - PRODUCTS

2.1 PIPING MARKERS

A. Acceptable Manufacturers:

1. W.H. Brady, Seton, Marking Systems, Inc. (MSI).
2. Other Manufacturers: Submit Substitution Request.

B. Pipes shall be labeled with all-vinyl, self-sticking labels or letters. For pipe covering sizes up to and including 3/4-inch outside diameter, select labels with 1/2-inch letters. For sizes from 3/4 to 2-inch outside diameter, 3/4-inch letters; above 2-inches outside diameter, 2-inch letters. The pipe markers shall be identified and color coded as follows with black directional arrows.

PLUMBING SERVICE	**BACKGROUND PIPE MARKER ***	**COLOR**
COLD WATER	"DOMESTIC COLD WATER"	GREEN
HOT WATER	"DOMESTIC HOT WATER SUPPLY"	YELLOW
	"DOM. HOT WATER RECIRC"	YELLOW OR GREEN
* Directional arrow applied adjacent to pipe marker indicating direction of flow.		
** Provide custom marker labels for all piping for which no standard manufactured marker is available. Submit sample for approval.		

PART 3 - EXECUTION

3.1 PIPING MARKERS

A. Unless recommendations of ANSI A13.1, 1981 are more stringent, apply labels or letters after completion of pipe cleaning, insulation, painting, or other similar work, as follows:

1. Every 20 feet along continuous exposed lines.
2. Every 10 feet along continuous concealed lines.
3. Adjacent to each valve and stubout for future.
4. Where pipe passes through a wall, into and out of concealed spaces.
5. On each riser.
6. On each leg of a "T".
7. Locate conspicuously where visible.
8. Provide pipe identification (over insulation) for all reclaimed water systems in accordance with current local codes and rulings.

B. Further, apply labels or letters to lower quarters of the pipe on horizontal runs where view is not obstructed or on the upper quarters when pipe is normally viewed from above. Apply arrow labels indicating direction of flow. Arrows to be the same color and sizes as identification labels.

END OF SECTION 220553

SECTION 220700 - INSULATION FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The provisions of Section 220500, Common Work Results for Plumbing apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes: Insulation for piping.

B. Related Sections include:

1. Section 220529 Hangers, Supports and Anchors for Plumbing.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements:

1. All insulating products shall comply with the Oregon Revised Statute (ORS) 453.005(7)(e) prohibiting pentabrominated, octabrominated and decabrominated diphenyl ethers. Where products within this specification contain these banned substances, provide complying products from approved manufacturers with equal performance characteristics.
2. Flame and Smoke Ratings: Installed composite flame spread not to exceed 25 and smoke developed not to exceed 50 as tested by UL 723.
3. Energy Codes: Local Building and Energy Codes shall govern where insulation performance requirements for thickness exceeds thickness specified.

B. Protection: Protect against dirt, water, chemical, or mechanical damage before, during, and after installation. Repair or replace damaged insulation at no additional cost.

C. Source Quality Control:

1. Service: Use insulation specifically manufactured for service specified.
2. Labeling: Insulation labeled or stamped with brand name and number.
3. Insulation and accessories shall not provide any nutritional or bodily use to fungi, bacteria, insects, rats, mice, or other vermin, shall not react corrosively with equipment, piping, or ductwork, and shall be asbestos free.

1.4 SUBMITTALS

A. Submit the following.

1. Product Data: For each type including density, conductivity, thickness, jacket, vapor barrier, and flame spread and smoke developed indices.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Equivalent products by Johns Manville, Knauf, Owens Corning, and CertainTeed are acceptable.

B. All such insulation shall be of one manufacturer.

C. Other Manufacturers: Submit Substitution Request.

2.2 PIPE INSULATION

A. Fiberglass: Split sectional or snap-on type with 0.23 per inch maximum thermal conductivity (K-factor) at 75°F mean temperature, 850°F maximum service rating and white, vapor barrier jacket with pressure sensitive closure system. Johns Manville Microlok HP.

B. Elastomeric: Expanded closed cell, 0.27 per inch maximum K-factor at 75°F mean temperature, 220°F maximum service rating with fitting covers and paintable surface. Armacell AP Armaflex, Rubatex.

C. Polyolefin: Semi-rigid polyolefin form snap-on or slip over type with 0.24 per inch maximum thermal conductivity (K-factor) at 75°F mean temperature -165°F to 210°F service factor and paintable surface. End joints in insulation on piping with fluid temperatures normally below 65°F fuse sealed in accordance with the manufacturer's instructions. Joints longitudinal joints and other end joints made with manufacturer's approval contact adhesive in accordance with the manufacturer's instructions. Joints may be pre-glued or pre-coated with adhesive where applicable.

2.3 ACCESSORIES PIPING

A. Adhesives:

1. Fiberglass: Zeston Z-Glu.
2. Elastomeric: Armacell 520.
3. Polyolefin: As approved by the insulation manufacturer.

B. Cements:

1. Insulating: Ryder.
2. Heat Transfer: Zeston Z-20.

C. Wire Mesh: 1-inch mesh with 20 gauge annealed steel wire.

D. Pipe Fitting Covers: One piece PVC insulated pipe fitting covers. Zeston, Ceel-Co.

E. Cloth Facing: Presized fiberglass cloth.

F. Tapes: Pressure sensitive, weather resistant, and for temperatures up to 150°F. Zeston Z-tape.

PART 3 - EXECUTION

3.1 GENERAL

A. Workmanship:

1. Installation: Insulation installed in first class, neat professional manner.
2. Applicators: Applicators shall be employed by firm that specializes in insulation work.

B. Preparation: Surfaces of piping and equipment clean, free of oil or dirt, and dry before insulation is applied.

C. Stamps: ASME stamps, UL labels, and similar stamps and labels shall not be covered.

3.2 PLUMBING PIPE AND EQUIPMENT INSULATION APPLIED LOCATIONS

A. Insulation Applied Locations – Plumbing Piping:

System	Pipe Size	Insulation Type	Insulation Thickness	Notes
Domestic Cold Water, Above Grade	1 1/4-inch and smaller	Fiberglass, all purpose jacket or Elastomeric or Polyolefin	1-inch	Note 1 Note 2
	Above 1 1/4-inch	Fiberglass, all purpose jacket	1 1/2-inch	Note 1
Domestic Hot Water Supply/Return, Above Grade	1 1/2-inch and smaller	Fiberglass, all purpose jacket or Elastomeric or Polyolefin	1 1/2-inch	Note 1 Note 2
	Above 1 1/2-inch	Fiberglass, all purpose jacket	2-inch	Note 1

System	Pipe Size	Insulation Type	Insulation Thickness	Notes
Domestic Hot Water Supply/Return, Below Grade	1 1/2-inch and smaller	Elastomeric or Polyolefin	1 1/2-inch	Note 1 Note 2
	Above 1 1/2-inch	Elastomeric or Polyolefin	2-inch	Note 1
Traps and trap priming lines (In unheated Spaces)	All	Fiberglass, all purpose jacket	1-inch	Insulate over heat tape
Condensate or other cold water drains	All	Elastomeric or Polyolefin	1/2-inch	Note 2
Note 1: Cover with metal pipe jacket where exposed to weather, and over heat trace cable. Note 2: Elastomeric or polyolefin insulation not allowed over heat trace cable. Note 3: Drain bodies, insulate the first 10 feet connected to the drain body, and all horizontal piping. Do not insulate main vertical stack.				

B. The following piping is not insulated:

1. Waste and vent, except where heat traced.
2. Domestic cold water runouts to single fixture less than 12-inch long and exposed supplies.
3. Priming lines except where heat traced.

C. Insulation shall include all fittings, unions, flanges, mechanical couplings, valve bodies, valve bonnets, piping through sleeves.

D. Valves and irregular fittings shall be insulated with section of pipe insulation and insulating cement, securely fastened, and finished with 6 oz. canvas and Foster 30-36 lagging adhesive. The contractor shall have the option on all flanges, valves, strainers, not requiring a vapor barrier to insulate with removable replaceable pads fabricated of 1-inch layer of Pittsburgh Corning Temp Mat sandwiched between inner and outer layer of 8 oz. glass cloth held together with stainless staples with sufficient stainless lacing hooks to hold pad firmly to flange or valve with minimum 3-inch overlap onto adjacent pipe insulation using 18 gauge S.S. lacing wire.

3.3 PIPING INSTALLATION

A. General:

1. Joints: Coat both sides of complete joining area with applicable adhesive.

   a. Longitudinal Joints: Make joints on top or back of pipe to minimize visibility. Except foam plastic, seal with closure system or 3-inch wide tape.
   b. Butt Joints: Butt lightly together and, except for foam plastic, seal with 3-inch wide tape or butt straps.
   c. Multiple Layered Insulation: Joints staggered.

2. Access: Strainer and other items requiring service or maintenance with easily removable and replaceable section of insulation to provide access.
3. Voids: Fill all voids, chipped corners and other openings with insulating cement or material compatible with insulating material. In insulation with Heat Tracing: Where piping is shown or specified to be heat traced, bed heat tape into heat transfer cement with insulation over heat tape and cement.
4. Seal joints, seams and fittings of metal watertight jackets at exterior locations.

B. Fiberglass Insulation: Exterior insulation encased in metal jacket.

C. Elastomeric and Polyolefin Insulation:

1. Slit full length and snap around pipe.
2. Make cuts perpendicular to insulating surface leaving no cut section exposed.
3. Do not stretch insulation to cover joints or fittings.
4. Seal joints in elastomeric insulation with adhesive.
5. Seal joints in polyolefin as specified hereinbefore.
6. Exterior insulation painted with two coats of specified paint in accordance with the manufacturer's instructions and encase in metal jacket.
7. Sealing joints with tape will not be allowed.

D. Fittings: Insulation specified with continuous vapor barrier, the vapor barrier must not be violated.

1. On Elastomeric and Polyolefin Insulation: Fittings covered with covers made up of mitered sections of insulation or with formed pipe fitting covers.
2. In Other Insulation: Fittings covered with insulation to the same level of the adjoining insulation or fill with insulating cement. Finish with pipe fitting covers or cloth facing and tape.

E. Unions, Mechanical Joints, Valves, Etc.:

1. General:

   a. As specified for fittings.
   b. Minimum thickness same as specified for piping.

2. Unions: Build up insulation at least 1/2-inch beyond adjoining insulation.
3. Flanges: With square corners. Where flanges are not insulated, terminate adjacent insulation so flange bolts can be removed.
4. Flanged Valves: Insulation with square corners.

F. Vapor Barrier Insulation:

1. Refer to Section 220529 for support requirements.

2. Piping which requires vapor barrier protection shall have a continuous vapor barrier, which may not be pierced or broken. The following piping systems require vapor barrier protection:

    a. Domestic cold water.
    b. Industrial cold water.
    c. Non-potable cold water.
    d. All other piping systems with a nominal operating temperature below 65°F.

3. Vapor Barrier Insulation:

    a. Insulation for pipe requiring vapor barrier protection 1-1/4-inch or smaller, insulation continuous through pipe hangers and rollers.
    b. For pipe 1-1/2-inch and larger, 18-inch section of calcium silicate, same thickness as pipe insulation with continuous vapor barrier jacket at each hanger or roller. Provide pipe shield specified in Section 220529.

G. Non-Vapor Barrier Insulation:

1. Refer to Section 220529 for support requirements.
2. At contractor's option, insulation may be interrupted at supports. Butt insulation tight to support.
3. If contractor elects to continue insulation at supports, installation as specified for piping systems with vapor barrier installation.
4. Void between saddle and pipe filled with insulation.

H. Expansion Joints: Covered with larger size pipe insulation to allow full movement and be removable, ends turned back to pipe, coat with vapor barrier mastic on joints in vapor barriered system and finished with cloth facing cemented to insulation with adhesive.

3.4 FIELD QUALITY CONTROL

A. Field Test: All systems shall be tested and approved prior to installation of insulation.

B. Existing Insulation:

1. Repair existing insulation damaged during construction.
2. Make neat connections where new and existing insulation meet.
3. Where existing piping, or equipment is removed, cover existing surfaces neatly to match existing.

END OF SECTION 220700

SECTION 222113- PIPE AND PIPE FITTINGS PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The provisions of Section 220500, Common Work Results for Plumbing apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes: Furnish piping, pipe fittings, and incidental related items as required for complete piping systems.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Piping material and installation to meet requirements of the local plumbing, fire, and building codes and serving utility requirements.
2. Provide chlorination of domestic cold and hot water piping in accordance with County and State health requirements.

B. Pipe Cleaning: Should any pipe be plugged or should foaming of water systems occur, disconnect piping, reclean, and reconnect without additional expense to the Owner.

C. Correct any damage to the building or systems resulting from failure to properly clean the system without additional expense to the Owner.

D. All products with a wetted surface installed in potable water systems shall be UL classified in accordance with ANSI / NSF-61 for potable water service, and shall be certified to the low lead requirements of NSF-372.

1.4 SUBMITTALS

A. Submit the Following:

1. List of piping materials indicating the service it is being used for. (Do not submit piping product data).

B. Test Reports and Certificates: Submit certificates of inspections and pipe tests to Owner.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. As indicated.

2.2 CAST IRON SOIL PIPE, SERVICE WEIGHT (NO-HUB)

A. General: A code approved hubless system conforming to Cast Iron Soil Pipe Institute Standard 301.

B. Pipe and Fittings: Service weight hubless cast iron conforming to ASTM A 74, marked with the collective trademark of the Cast Iron Soil Pipe Institute (CISPI) and listed by NSF International. Tyler, AB&I, or Charlotte.

C. Gaskets: Compression type conforming to ASTM C 564.

D. Couplings:

1. Above Grade: Band type coupling in conformance with Cast Iron Soil Pipe Institute (CISPI) 310-90, consisting of stainless steel clamp and corrugated shield assemblies with a neoprene sealing sleeve ANSI A21.6, ANSI A21.10 Fittings.

2.3 GALVANIZED STEEL PIPE

A. Pipe: Schedule 40 conforming to ASTM A 135 or A 53.

B. Fittings: 150 lb. screwed galvanized malleable iron on 2-inch and below, Victaulic, Gruvlok, Gustin-Bacon, or Mech Line full flow galvanized, grooved end on 2-1/2-inch and above. Provide grooved type gasketed couplings and fittings for pipe 2-1/2-inch and above.

C. Service:

1. At Contractor’s option, waste and vent piping 1-1/2 inches and under, above grade.

2.4 COPPER PIPE

A. Pipe: Hard drawn copper tubing, Class L or K, ASTM B 88.

B. Fittings: Wrought copper, 150 psi; ANSI B16.22 for soldered joints, ANSI B16.50 for brazed joints; Chase, Revere, Mueller or approved equal. At contractor's option, a system using mechanically extracted collars in main with branch line inserted to not obstruct flow may be used on domestic water piping above ground, similar to T-drill.

C. Service:

1. Domestic hot and cold water piping below ground (Type K, hard drawn) on piping 3 inches and smaller.
2. Domestic hot and cold water piping above ground (Type L, hard drawn) on piping 4 inches and smaller.
3. Trap priming lines (Type L, annealed).
4. Miscellaneous drains and overflows.

2.5 PVC PIPE (DWV)

A. Pipe: PVC, wall thickness equal to Schedule 40 standard steel pipe, conforming to ASTM D2665-85a.

B. Fittings: PVC building drain, waste, and vent fittings conforming to ASTM D2665-85 and ASTM D3311-82.

C. Solvent Cement: For PVC pipe conforming to ASTM D2564-80.

D. Service: Sanitary waste and vent, except not allowed in return air plenums.

2.6 ABS PIPE (DWV)

A. Pipe: ABS, wall thickness equal to schedule 40 standard steel pipe, conforming to ASTM D2661-85a.

B. Fittings: ABS waste and vent fittings conforming to ASTM D2661-85a and ASTM D3311-82.

C. Solvent Cement: For ABS pipe conforming to the requirement of ASTM D2235-81.

D. Service: Sanitary waste and vent, storm and overflow, except not allowed in return air plenums.

2.7 PEX POTABLE WATER TUBING

A. Acceptable Manufacturers:

1. Wirsbro, Uponor.
2. Other Manufacturers: Submit Substitution Request.

B. Regulatory Listings: Submit appropriate NSF International, UL, Warnock Hesey or CSA listings as proof of compliance with local building and plumbing codes.

C. PEX tubing and components shall be installed in full compliance with all local jurisdictional codes, standards and requirements.

D. Submit listings that indicated that the PEX tubing system has been certified to ANSI/NSF Standards 14 and 61.

E. Quality Assurance:

1. Installer Qualifications: Installer experienced in performing work of this Section who has specialized in installation of work similar to that required for this project.
2. Installer shall provide in writing to the Owner that the PEX tubing and components furnished under this Section conforms to the material and mechanical requirements specified herein.

F. Materials:

1. Tube Materials: Tube shall be cross-linked polyethylene (PEX) manufactured by PEX-A or peroxide method. Provide "blue" colored PEX for cold water systems and "red" colored PEX for hot water systems.
2. Tubing Type: PEX tubing shall be manufactured in accordance with ASTM F876, ASTM F877 and CAN/CDA-B137.5. The tube shall be listed to ASTM by an independent third party agency.

    a. PEX tubing shall have Standard Grade hydrostatic design and pressure ratings of 200°F at 80 psi and 180°F at 100 psi. Temperature and pressure ratings shall be issued by the Plastic Pipe Institute (PPI).
    b. Minimum bend radius for cold bending of the PEX tubing shall not be less than 6 times the outside diameter. Bends with the radius less than stated shall require the use of a bend support as supplied by tube manufacturer.

3. Manifold Type: Wirsbro Type "L" Q-Series copper manifold with integral valves.
4. Fittings: Fittings shall be brass. Fittings shall be PEX-A cold expansion type fitting. Wirsbro ProPEX fittings.

    a. Fittings shall be supplied by the PEX tubing manufacturer.
    b. PEX fittings shall be manufactured in accordance with ASTM F1960. The fittings shall be listed to ASTM by an independent third party agency.
    c. PEX-A cold expansion type fittings shall be an assembly consisting of insert and PEX-A cold expansion ring.

G. Accessories:

1. Wall Penetration Brackets: Brackets designed for wall membrane penetrations shall be supplied by PEX tubing manufacturer; Wirsbro Drop Ear Bend Support.
2. Concrete Tube Support Brackets: Brackets to hold PEX tubing in place in structural concrete slabs shall be of rigid PVC construction and be designed for that purpose.
3. Wirsbro "Stand-Up" bracket.

H. Service: Domestic cold and hot water supply drops to individual lavatories, sinks, tank type toilets and to the shower mixing valves. PEX tubing shall not serve any fixtures with fast closing valves (flush valves, solenoid valves, etc.) and shall not be used downstream of the shower mixing valve. Domestic water piping distribution systems serving PEX manifolds shall be copper.

2.8 FLANGED JOINTS

A. Flanged Joints: Flanges shall be cast iron or steel for screwed piping and forged steel welding neck for welded line sizes. Pressure rating and drilling shall match the apparatus, valve, or fitting to which they are attached. Flanges shall be in accordance with ANSI B16.1; 150 lb. for system pressures to 150 psig; 300 lb. for system pressures 150 psig to 400 psig. Gaskets for all flanged services, except steam and pumped condensate, shall be Garlock 3700 or equal, 1/8-inch thick, non-metallic type. Gaskets for steam and pumped condensate shall be Flexitaulic Style CG or equal, 1/8-inch thick, semi-metallic type. Make joint using American Standard hexagon head bolts, lock washers, and nuts (per ASTM A307 GR.B) for service pressures to 150 psig; alloy steel stud bolts, lock washer, and American Standard hexagon head nuts (per ASTM A307 GR.B) for service pressures 150 psig to 400 psig. Use length of bolt required for full nut engagement. Provide electro-cad plated bolts and nuts on cold and chilled water lines.

2.9 UNIONS

A. 150 psi malleable iron, brass to iron seat, ground joint, black or galvanized to match pipe. 200 psi WOG bronze, ground joint, solder type for copper tubing.

1. Unions or flanges for servicing or disconnect are not required in installations using grooved mechanical joint couplings. (The couplings shall serve as disconnect points.)

B. Dielectric fittings shall be nationally listed, have a dielectric thermoplastic interior lining, and meet requirements of ASTM F-492. Fittings shall be suitable for the pressure and temperature to be encountered.

2.10 SOLDER AND BRAZING

A. Brazed Joints:

1. Wrought Copper Piping Fittings: Westinghouse Phos-Copper or Dyna-Flow by J.W. Harris Co., Inc.

2. Applied locations:

    a. All below grade piping.
    b. All above grade piping larger than 2-inches for the following services: Industrial cold water, domestic hot and cold water.
    c. Joints in Domestic Hot and Cold Water Piping: Use mechanically extracted collars. Braze in accordance with Copper Development Association Copper Tube Handbook using BCUP series filler material.

B. Soldered Joints:

1. Wrought Copper Pipe Fittings: All-State 430 with Duzall Flux, Engelhard Silvabrite with Engelhard General Purpose Flux or J.W. Harris Co.
2. Valves, Cast Fittings or Bronze Fittings: Harris Stay-Silv-15 or Handy & Harmon Sil-Fos.
3. Applied locations: Above grade piping 2-inch and smaller for the following services: Industrial cold water, domestic hot and cold water, trap priming lines.

2.11 UTILITY MARKERS

A. Provide plastic tape utility markers over all buried piping. Provide identification on tape.

B. Material to be Brady Identoline plastic tape, 6-inch, Seton, or as approved.

2.12 PIPE WRAPPING

A. For all below ground steel piping and fittings, provide complete covering of Scotchrap No. 51, 20 mil thickness, protective tape applied over Scotchrap pipe primer applied at 1 gal/800 SF of pipe surface.

B. At Contractor's option as approved, pipe may be furnished with factory applied jacket of "X-tru-coat" with Scotchrap as previously specified for field joints.

PART 3 - EXECUTION

3.1 PREPARATION

A. Measurements, Lines and Levels:

1. Check dimension at the building site and establish lines and levels for work specified in this Section.
2. Establish all inverts, slopes, and manhole elevations by instrument, working from an established datum point. Provide elevation markers for use in determining slopes and elevations in accordance with Drawings and Specifications.
3. Use established grid and area lines for locating trenches in relation to building and boundaries.

3.2 EXCAVATION AND BACKFILL

A. General: Perform all necessary excavation and backfill required for the installation of mechanical work in accord with Division 2. Repair pipelines or other work damaged during excavation and backfilling.

B. Excavation: Excavate trenches to the necessary depth and width, removing rocks, roots, and stumps. Include additional excavation to facilitate utility crossovers, additional offsets, etc. Excavation material is unclassified. Width of trench shall be adequate for proper installation of piping. The trench shall be widened, if not wide enough for a proper installation.

C. Bedding: All cast iron, steel, and copper piping shall be full bedded on sand. Place a minimum 4-inch deep layer on the leveled trench bottom for this purpose. Remove the sand to the necessary depth for piping bells and couplings to maintain contact of the pipe on the sand for its entire length. Lay all other piping on a smooth level trench bottom so that contact is made for its entire length.

D. Backfill: Place in layers not exceeding 8 inches deep, and compact to 95% of standard proctor maximum density at optimum moisture content. Earth backfill shall be free of rocks over 2 inches in diameter and foreign matter. Disposal of excess material as directed.

1. Interior: All backfill under interior slabs shall be bank sand or pea gravel.
2. Exterior: Excavated material may be used outside of buildings at the Contractor's option. The first 4 inches shall be sand, and final 12-inch layer course shall be soil in any event.

3.3 PIPING INSTALLATION

A. Install unions in all non-flanged piping connections to apparatus and adjacent to all screwed control valves, traps, and appurtenances requiring removal for servicing so located that piping may be disconnected without disturbing the general system.

B. Install all piping as to vent and drain. Install according to manufacturer's recommendations.

C. Support all piping independently at apparatus so that its weight shall not be carried by the equipment.

D. Run piping clear of tube cleaning or removal/replacement access area on heat exchangers, water heaters, etc.

E. Dielectric Fittings: Provide dielectric couplings, unions, or flanges between dissimilar metals. In addition, provide dielectric couplings as required to isolate cathodically protected piping and equipment.

F. No-Hub Couplings: Install per manufacturer's instructions.

G. PEX System: Installation shall comply with manufacturer's product data, including product technical bulletins, installation instructions and product carton instructions for installation.

1. PEX tubing passing through metal studs shall be provided with grommets or sleeves at the penetration.
2. Protect PEX tubing with sleeves where abrasion may occur.
3. Use strike protectors where PEX tubing has the potential for being struck with a screw or nail.

3.4 PIPING JOINTS

A. Pipe and fittings shall be joined using methods and materials recommended by manufacturer in conformance with standard practice and applicable codes. Cleaning, cutting, reaming, grooving, etc. shall be done with proper tools and equipment. Hacksaw pipe cutting prohibited. Peening of welds to stop leaks not permitted.

B. Copper Piping: Pipe cut evenly with cutter, ream to full inside diameter; end of pipe and inside of fitting thoroughly cleaned and polished. Joint shall be uniformly heated, and capillary space completely filled with solder or braze material, leaving full bead around entire circumference.

C. No couplings installed in floor or wall sleeves.

D. Steel Piping:

1. Screwed Joints: Pipes cut evenly with pipe cutter reamed to full inside diameter with all burrs and cuttings removed. Joints made up with Teflon liquid dope or Teflon tape applied to male threads only, leaving two threads bare. Joints tightened so that not more than two threads are left showing. Junctions between galvanized steel waste pipe and bell of cast iron pipe shall be made with tapped spigot or half coupling on steel pipe to form spigot end and caulked.
2. Flanged Joints: Pressure rating of flanges shall match valve or fitting joined. Joint gaskets shall be coated with graphite and oil.

E. Flexible Connector: Provide where indicated on the Drawings.

F. PVC Piping: Socket weld joints with solvent cement and application method recommended by manufacturer. Use power saw and miter box to cut PVC pipe, except DI piping must be cut with a wheel cutter specifically made for plastics. Allow proper curing time based on temperature range during cure period before pressure testing.

G. ABS Piping: Socket weld joints with solvent cement and application method recommended by manufacturer, use power saw and miter box to cut ABS pipe. Allow proper curing time based on temperature range during cure period before pressure testing.

H. Above Grade No-Hub Couplings:

1. Install in accordance with manufacturer recommendations.

3.5 ADJUSTING AND CLEANING

A. General:

1. Clean interior of all piping before installation.
2. Flush sediment out of all piping systems after installation before connecting plumbing fixtures to the piping.
3. When placing the water systems in service during construction, each system shall be cleaned in accordance with specification 222500 “Plumbing Water Treatment” prior to being placed in service.
4. Clean all strainers prior to placing in service.

END OF SECTION 222113

SECTION 224000 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The provisions of Section 220500, Common Work Results for Plumbing HVAC apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes:

1. Plumbing fixtures.
2. Fixture trim.
3. Drainage products.
4. Miscellaneous plumbing items.

1.3 QUALITY ASSURANCE

A. Water closets shall have Maximum Performance (MaP) score of no less than 800.

B. Faucets shall be certified to NSF/ANSI 61 and California AB1953.

C. Drinking Fountains shall be certified to NSF/ANSI 61 and California AB1953.

1.4 SUBMITTALS

A. Submit the following:

1. Product data for each item specified.
2. Operating and Maintenance Data:

    a. Garbage disposals.

3. Mounting heights for all fixtures.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Manufacturers are stated for each fixture specified. The following manufacturers are also acceptable, except when indicated "only".

B. Drainage Products and Carrier Products: J.R. Smith, Josam, Sioux Chief, Zurn, Wade, Watts Drainage, Woodford, Mifab.

C. Fixtures: American Standard, Kohler, Sloan, Toto.

D. Seats: Olsonite, Church, Beneke, Bemis.

E. Drinking Fountains: Elkay, Halsey Taylor, Oasis, Sunroc, Haws.

F. Mixing Valves: Powers, Leonard, Symmons, Chicago.

G. Stainless Steel Products: Elkay, Just, Franke.

H. Faucets: Chicago, Delta Commercial, Kohler, Moen Commercial.

I. Metering Faucets: Chicago, Symmons.

J. Hot Water Dispenser: In-Sink-Erator.

K. Flush Valves: Sloan, Zurn.

L. Shock Arrestors: PPP, J.R. Smith.

M. Exposed Waste and Supply Piping Insulation Kits: Truebro, McGuire.

N. Other Manufacturers: Submit Substitution Request.

2.2 FIXTURE TRIM

A. Supply Stops: Chicago cast brass rigid riser supplies with loose key angle stops, wall flanges, NPT female inlet, all chrome plate finish; equivalent NPT McGuire (LK series), Brasscraft (SCR series) or NPT stops by fixture supplier.

B. Traps:

1. For floor drains, provide coated cast iron P-trap; recessed, screw jointed or bell and spigot.
2. For other fixtures, provide 17 gauge, chrome plated cast brass P-Traps with solder bushings, and clean-out.

C. Support Rims: Hudee stainless steel rims, if sink not furnished with integral rim.

D. Vacuum Breakers: Chicago Faucet, A.W. Cash or Febco chrome plated.

2.3 PLUMBING FIXTURES

A. WC-1 Water Closet:

1. Kohler "Kingston", vitreous china, wall hung, elongated bowl, siphon jet action, 1-1/2-inch top spud, white color finish. Complete with Sloan Royal diaphragm type flush valve with dual filtered fixed bypass (1.6 GPF).
2. Bemis 1600 series white open-front seat, less cover with external check hinge including 300 series stainless steel post and pintles to stop seat at 11 degrees beyond vertical.
3. J.R. Smith Series 200 chair carrier.

B. L-1 Lavatory :

1. Kohler Kingston 21-1/4 x 18-1/8-inch, vitreous china, self-draining deck, backsplash, 4-inch centers, wall hung, concealed arm support, grid drain, white color finish.
2. Chicago 802 series faucet with polished chrome plated solid brass body construction, 4-inch spout, vandal proof metering push handle, 1/2 GPM pressure compensating aerator, adjustable cycle time closure cartridge, vandal resistant complete.

C. S-1 Sink:

1. Elkay LR series, 33x19x7-1/2-inch double compartment 18 gauge, type 302, 4-hole, self-rimming stainless steel sink, each compartment 14x14x7-1/2-inch deep (2) LK-35 basket strainers.
2. Chicago 2301 series faucet with polished chrome plated solid brass body construction, single lever mixing valve, 10-inch cast brass spout, hand spray, high temperature limit stop, 8-inch trim plate, 1.5 GPM pressure compensating laminar flow outlet, vandal resistant complete.
3. In-Sink-Erator Model H-770 hot water dispenser, able to produce 60 cups of 190°F hot water per hour, adjustable thermostat, 750 watt, 115 volt.

D. EWC-1 Electric Water Cooler (ADA): Elkay EZH20 series dual height wall hung water cooler with bottle filling station

1. Surface mounted.
2. Push pad operated bubblers.
3. Anti-microbial bubbler guards.
4. Bottle Filler:

    a. Sensor Activated.
    b. 20 second automatic shut-off.
    c. 1.1 GPM.

5. Water Chiller: 8 GPH, 50 degree F. water at 90 degree F ambient and 80 degree F. inlet water temperature. 120V, single phase, 5 FLA.
6. 3000 gallon water filter.

E. Mixing Valve (Point-of-Use): Leonard 270 series thermostatic point-of-use mixing valve, bronze body, locked temperature adjustment cap (vandal resistant), integral check valves on hot and cold inlets, minimum flow 0.5 GPM and maximum 3.5 GPM flow rates at 5 PSI loss.

F. Exposed Waste and Supply Piping Insulation Kits: McGuire Prowrap insulation kit for exposed supplies and waste piping below ADA lavatories and ADA sinks.

2.4 DRAINAGE PRODUCTS

A. HB-1 Hose Bibb: Chicago 952 series, chrome-plated, removable key, 3/4-inch hose thread, integral vacuum breaker.WH-1 Wall Hydrant: J.R. Smith 5609 series, bronze finish, removable key, 3/4-inch hose thread, integral vacuum breaker, freeze proof.

B. FD-1 Floor Drain: J.R. Smith 2005 series, round nickel bronze vandal resistant grate, cast iron body with flashing collar and adjustable strainer head and no-hub outlet.

C. WCO Wall Cleanout: J.R. Smith 4530 series, round stainless steel vandal resistant cover and screw.

D. FCO Floor Cleanout: J.R. Smith 4020 series, round vandal resistant, nickel bronze top.

E. CTG Cleanout to Grade: J.R. Smith 4220 series, round, extra heavy duty cast iron top set in 12x12x4-inch deep concrete pad, vandal resistant.

F. SB-1 Supply Box: Sioux Chief 696R series fire-rated ice maker supply box with bottom valve supply and shock arrestor.

G. Trap Priming Valves: Vacuum breaker trap primer, Sloan VBF-72-A, to divert water from flush valve to floor drain trap.

H. Water Hammer Arrester: Precision Plumbing Products Model SC (Maintenance-Free).

PART 3 - EXECUTION

3.1 FIXTURE TRIM

A. Provide plumbing fixture trim where applicable on fixtures, including but not limited to supply stops, traps, support rims, flush valve, and vacuum breakers.

B. Provide rough-in and final piping connection to fixtures. Carefully review all construction documents to assure that all fixtures are provided with necessary services for a complete operating system.

C. Rigidly secure rough-in piping, carriers and supports, and other service piping to structure.

3.2 PLUMBING FIXTURES

A. Americans with Disabilities Act:

1. Those fixtures indicated by "ADA" shall comply with and be installed in accordance with Americans with Disabilities Act Guidelines (ADAAG). Where applicable building code requirements are more stringent than ADAAG guidelines, building code requirements shall be followed.
2. Water Closets:

    a. Mounting height of ADA water closet shall be 17 to 19 inches from floor to top of the toilet seat.
    b. Mount flush valve for ADA water closets on wide side of enclosure.

3. Lavatories:

    a. Mounting height of ADA lavatories shall be at a maximum height of 34 inches from floor to rim.
    b. Provide insulation kits on exposed hot water and waste piping beneath ADA lavatories.

4. Sinks: Provide insulation kits on exposed hot water and waste piping beneath ADA sinks.

B. Fixture Mounting Heights: All fixtures standard rough-in catalogued heights unless shown otherwise on the Architectural Drawings.

C. Water Supplies: When both hot and cold water to a fixture is required, connect the hot on the left and the cold on the right.

D. Floor Mounted Supports and Chair Carriers: Secure floor mounted supports and chair carriers to slab with a minimum of 1/2-inch bolts. Install supports and carriers per manufacturer's installation instructions.

E. Lavatories:

1. Public toilet room lavatories shall have grid strainers.
2. Those lavatories indicated as "ADA" are ADA compatible. Coordinate with Architect to verify if all wall hung lavatories are to be installed at ADA height.

F. Floor Drain:

1. Set top flush with finished floor.
2. Provide flashing clamp for all drain bodies installed in floors provided with waterproof membranes.

G. Cleanout:

1. Where shown or required.
2. Cover set flush with finished surface.

H. Water Hammer Arresters: Provide where shown and where recommended by Plumbing Drainage Institute (PDI).

I. Mixing Valves: Provide piping connections per manufacturer's installation instructions.

3.3 PRIMING VALVES

A. All floor drains and similar traps shall be primed. Use minimum 3/8-inch type K annealed copper tubing. Primer line to be continuous and without joints.

B. Where priming valves are installed in finished rooms, conceal in wall and provide access panel.

END OF SECTION 224000

SECTION 230500 - COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The provisions of This Section, Common Work Results for HVAC, apply to all sections in Division 23.

C. All Sections of Division 23 are interrelated. When interpreting any direction, material, and method specified in any section of Division 23, consider it within the entirety of Work in Division 23.

1.2 SUMMARY

A. The intent of Division 23 Specifications and the accompanying Drawings is to provide a complete and workable facility with complete systems as shown, specified and required by applicable codes. Include all work specified in Division 23 and shown on the accompanying Drawings, including appurtenances, connections, etc., in the finished job.

B. The Division 23 Specifications and the accompanying Drawings are complementary and what is called for by one shall be as binding as if called for by both. Items shown on the Drawings are not necessarily included in the Specifications and vice versa. Specifications shall supersede drawings in case of conflict.

C. Imperative language is frequently used in Division 23 Specifications. Except as otherwise specified, requirements expressed imperatively are to be performed by the Contractor.

D. The Drawings that accompany the Division 23 Specifications are diagrammatic. They do not show every offset, bend, tee, or elbow which may be required to install work in the space provided and avoid conflicts. Offsets and transitions shall be assumed at a minimum at each duct crossing, structural penetrations through shear walls or beams, structural grids where ceiling heights are restricted, and at piping mains. Follow the Drawing as closely as is practical to do so and install additional bends, offsets and elbows where required by local conditions from measurements taken at the Building, subject to approval, and without additional cost to the Owner. The right is reserved to make any reasonable changes in outlet location prior to roughing-in, without cost impact.

1.3 RELATED WORK

A. The General and Supplemental Conditions apply to this Division, including but not limited to:

1. Drawings and specifications.
2. Public ordinances, permits.
3. Include payments and fees required by governing authorities for work of this Division.

B. Division 1, General Requirements, applies to this Division.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements:

1. All products and equipment shall be prohibited from containing pentabrominated, octabrominated and decabrominated diphenyl ethers. Where products or equipment within this specification contain these banned substances, provide complying products and equipment from approved manufacturers with equal performance characteristics.
2. General: All work and materials shall conform to the local and State codes, and all Federal, State and other applicable laws and regulations.
3. Contractor responsible for obtaining and payment for all permits, licenses, and inspection certificates required in accordance with provisions of Contract Documents.

B. Materials and equipment shall be new. Work shall be of good quality, free of faults and defects and in conformance with the Contract Documents.

C. Apparatus shall be built and installed to deliver its full rated capacity at the efficiency for which it was designed.

D. The entire mechanical system and apparatus shall operate at full capacity without objectionable noise or vibration.

E. All equipment shall be installed level and true. Housekeeping pads and curbs shall account for floor or roof slope.

F. Materials and Equipment:

1. Each piece of equipment furnished shall meet all detailed requirements of the Drawings and Specifications and shall be suitable for the installation shown. Equipment not meeting all requirements will not be acceptable, even though specified by name along with other manufacturers.
2. Where two or more units of the same class of equipment are furnished, use products of the same manufacturer. Component parts of the entire system need not be products of same manufacturer.
3. Furnish all materials and equipment of size, make, type, and quality herein specified.

4. Equipment scheduled by performance or model number shall be considered the basis of the design. If other specified manufacturer's equipment is provided in lieu of the basis of design equipment the contractor is responsible for all changes and costs which may be necessary to accommodate this equipment, including different sizes and locations for connections, different electrical characteristics, different dimensions, different access requirements or any other differences which impact the project.

G. Workmanship:

1. General: All materials shall be installed in a neat and professional manner.
2. Manufacturer's Instructions: Follow manufacturer's directions where they cover points not specifically indicated. If they are in conflict with the Drawings and Division 23 Specifications, obtain clarification before starting work.

H. Cutting and Patching:

1. Cutting, patching, and repairing for the proper installation and completion of the work specified in this Division including plastering, masonry work, concrete work, carpentry work, and painting shall be performed by skilled craftsmen of each respective trade in conformance with the appropriate Division of Work.
2. Additional openings required in building construction shall be made by drilling or cutting. Use of jackhammer is specifically prohibited.
3. Fill holes which are cut oversize so that a tight fit is obtained around the sleeves passing through.
4. Beams or columns shall not be pierced without permission of Architect and then only as directed.
5. All new or existing work cut or damaged shall be restored to its original condition. Where alterations disturb lawns, paving, walks, etc., the surfaces shall be repaired, refinished, and left in condition existing prior to commencement of work.

1.5 SUBMITTALS

A. Shop Drawings:

1. The Contract Drawings indicate the general layout of the piping, ductwork, and various items of equipment. Coordination with other trades and with field conditions will be required. For this purpose, prepare Shop Drawings of all piping, ductwork and equipment installations. Shop Drawings shall be new drawings prepared by Contractor and not reproductions or tracings of Architect's Drawings. Overlay drawings with shop drawings of other trades and check for conflicts. All drawings shall be same size as Architect's Drawings with title block similar to Contract Drawings and identifying Architect's Drawing number or any reference drawings. All drawings shall be fully dimensioned including both plan and elevation dimensions. Shop drawings cannot be used to make scope changes.
2. Shop drawings shall be prepared in two-dimensional format.

3. Shop drawings shall include but are not limited to:

    a. Complete floor plans with sheet metal and HVAC piping to a minimum of 1/4-inch equals 1'-0" scale.
    b. Sheet metal and HVAC piping of mechanical and fan rooms to a minimum of 1/2-inch equal 1'-0" scale.
    c. Sections of congested areas to a minimum of 1/4-inch = 1'-0" scale.
    d. Controls and Instrumentation: Scale and drawing sizes to suit controls supplier.
    e. Fabricated Equipment: Scale and drawing sizes to suit contractor except equipment shall not be less than 1/4-inch equals 1'-0" scale.

4. Submit shop drawings for review prior to beginning fabrication. Additional shop drawings may be requested when it appears that coordination issues are not being resolved in the field or when there is a question as to whether contract documents are being complied with or the design intent is being met.

B. Product Data:

1. In general, submit product data for review on all scheduled pieces of equipment, on all equipment requiring electrical connections or connections by other trades, and as required by each specification section or by Drawing notes. Include manufacturer's detailed shop drawings, specifications and data sheets. Data sheets shall include capacities, RPM, BHP, pressure drop, design and operating pressures, temperatures, and similar data. Manufacturer's abbreviations or codes are not acceptable.
2. List the name of the motor manufacturer and service factor for each piece of equipment.
3. Indicate equipment operating weights including bases and weight distribution at support points.
4. In the case of equipment such as wiring devices, time switches, valves, etc., specified by specific catalog number, a statement of conformance will suffice.

C. Submission Requirements:

1. Shop Drawings and Product Data:

    a. Refer to Division 1 for additional requirements related to submittals.
    b. Submit electronic copies of shop drawings and product data for Work of Division 23 in PDF format with each item filed under a folder and labeled with its respective specification section number, article and paragraph and mark if applicable.
    c. Include a complete index in the original submittal. Indicate both original items submitted and note stragglers that will be submitted at a later date to avoid delay in submitting.
    d. The bulk of the shop drawings and product data, excepting Controls and Instrumentation, shall be included with the original submittal. Controls and Instrumentation submittals may lag but shall be complete when submitted. Partial submittals will not be accepted. Other stragglers submitted after return of the original binder shall include a tab similar to that originally submitted. Upon receipt of the returned late submittal, insert them in the previously submitted binder.

D. Contractor Responsibilities: It shall be the Contractor's responsibility to:

1. See that all submittals are submitted at one time and are in proper order.
2. Ensure that all equipment will fit in the space provided.
3. Assure that all deviations from Drawings and Specifications are specifically noted in the submittals. Failure to comply will void review automatically.

1.6 OPERATING AND MAINTENANCE MANUAL, PARTS LISTS, AND OWNERS INSTRUCTIONS

A. Refer to Division 1 for additional requirements.

B. Submit three bound copies of manufacturer's operation and maintenance instruction manuals and parts lists for each piece of equipment or item requiring servicing. Literature shall be on 8-1/2"x11" sheets or catalogs suitable for side binding. Submit data when the work is substantially complete, packaged separately, and clearly identified in durable 3-ring binder. Include name and contact information for location of source parts and service for each piece of equipment. Clearly mark and label in each submittal, the piece of equipment provided with the proper nameplate and model number identified. Provide wiring diagrams for all electrically powered equipment.

C. Instruct Owner thoroughly in proper operation of equipment and systems, in accordance with manufacturer's instruction manuals. Operating instructions shall cover all phases of control.

1.7 PROJECT CONDITIONS

A. Existing Conditions: Prior to bidding, verify and become familiar with all existing conditions by visiting the site, and include all factors which may affect the execution of this Work. Include all related costs in the initial bid proposal.

B. Coordinate exact requirements governed by actual job conditions. Check all information and report any discrepancies before fabricating work. Report changes in time to avoid unnecessary work.

C. Coordinate shutdown and start-up of existing, temporary, and new systems and utilities. Notify Owner, City and Utility Company.

1.8 WARRANTY

A. Provide a written guaranty covering the work of this Division (for a period of one calendar year from the date of acceptance by the Owner) as required by the General Conditions.

B. Provide manufacturer's written warranties for material and equipment furnished under this Division insuring parts and labor for a period of one year from the date of Owner acceptance of Work of this Division.

C. Correct warranty items promptly upon notification.

1.9 PROVISIONS FOR LARGE EQUIPMENT

A. Contractor shall make provisions for the necessary openings in building to allow for admittance of all equipment.

1.10 TEST REPORTS AND CERTIFICATES

A. Contractor shall submit one copy of all test reports and certificates specified herein to the Architect.

1.11 SUBSTITUTIONS

A. Contractor shall submit any requests for product substitutions in accordance with the Instructions to Bidders and the General and Supplemental Conditions.

PART 2 - PRODUCTS

2.1 PIPE AND DUCT SLEEVES

A. Interior Wall and Floor Sleeves: 18 gauge galvanized steel, or another pre-approved system.

B. Interior Wall and Floor Sleeves (fire rated): Fire rated and water tight system approved by Authority Having Jurisdiction and Owners Insurance underwriter, with rating equal to floor or wall penetration, and designed specifically for the floor or wall construction, piping material, size and service.

C. On Grade Floor Sleeves: Same as exterior wall sleeves.

D. Water Tight Sleeves: Combination steel pipe sleeves with water stop and anchor plate; Link Seal Model WS, mated with synthetic rubber links interlocked with bolts and nuts; Link Seal Model LS.

2.2 FLOOR, WALL AND CEILING PLATES

A. Furnish stamped split type plates as follows:

1. Floor Plates: Cast brass, chromium plated.
2. Wall and Ceiling Plates: Spun aluminum.

2.3 ELECTRICAL EQUIPMENT

A. General: All equipment and installed work shall be as specified under Division 26, Electrical.

B. Coordinate with the electrical Drawings and electrical contractor for minimum electrical equipment bracing requirements based on the available fault current rating at the bus of the panelboard or switchboard serving the piece of equipment. Provide equipment with a Short Circuit Current Rating (SCCR) that meets the bracing requirement.

C. Motors – Electronic Commutation (EC):

1. Motors shall be furnished as integral part of driven equipment.
2. Permanently lubricated with ball bearings unless noted otherwise.
3. Internal motor circuitry shall convert AC power supplied to the motor to DC power to operate the motor.
4. Motor shall be speed controllable down to 20% of full speed.
5. Motor efficiency shall be minimum of 85% at all speeds.
6. Refer to Equipment Schedules on the Drawings for motor horsepower, voltage and phase.
7. Refer to individual product sections for additional motor requirements.
8. Motors shall have built-in thermal overload protection, or be protected externally with separate thermal overload devices with low voltage release or lockout. Hermetically sealed motors shall have quick trip devices.

D. Equipment Wiring: Interconnecting wiring within or on a piece of mechanical equipment shall be provided with the equipment unless shown otherwise. This does not include the wiring of motors, starters and controllers provided under Division 26, Electrical.

E. Control Wiring: All control wiring for mechanical equipment shall be provided under Section 23 09 00, Instrumentation and Controls for HVAC.

F. Codes: All electrical equipment and products shall bear the Underwriters label as required by governing codes and ordinances.

PART 3 - EXECUTION

3.1 SLEEVES

A. Interior Floor and Wall Sleeves: Provide sleeves large enough to provide 3/4-inch clearances around pipe or ductwork. Where pipe or ductwork is insulated, insulation shall pass continuously through sleeve with 3/4-inch clearance between insulation and sleeve. Penetrations through mechanical room and fan room floors shall be made watertight by packing with safing insulation and sealing with Tremco Dymeric Sealant or approved system.

B. Layout work prior to concrete forming. Do all cutting and patching required. Reinforce sleeves to prevent collapse during forming and pouring.

C. All floor sleeves shall maintain a water barrier by providing a water tight seal or they shall extend 1-inch above finished floor except through mechanical equipment room floors and shafts where sleeves shall extend 2 inches above finished floor level. Sleeves through roof shall extend 8 inches above roof. Wall sleeves shall be flush with face of wall unless otherwise indicated.

D. Do not support pipes by resting pipe clamps on floor sleeves. Supplementary members shall be provided so pipes are floor supported.

E. Special sleeves detailed on drawings shall take precedence over this section.

3.2 CLEANING

A. General: Clean mechanical equipment, piping and ductwork of stampings and markings (except those required by codes), iron cuttings, and other refuse.

B. Painted Surfaces: Clean scratched or marred painted surfaces of rust or other foreign matter and paint with matching color industrial enamel, except as otherwise noted.

C. Additional requirements are specified under specific Sections of this Division.

3.3 EQUIPMENT PROTECTION

A. Keep pipe, ductwork and conduit openings closed by means of plugs or caps to prevent the entrance of foreign matter. Protect piping, conduit, ductwork, equipment and apparatus against dirty water, chemical or mechanical damage both before and after installation. Restore damaged or contaminated fixtures, equipment, or apparatus to original conditions or replace at no cost to the Owner.

B. Protect bright finished shafts, bearing housings, and similar items until in service. No rust will be permitted.

C. Cover or otherwise suitably protect equipment and materials stored on the job site.

3.4 ACCESSIBILITY

A. General: Locate valves, thermometers, cleanout fittings and other indicating equipment or specialties requiring frequent reading, adjustments, inspection, repairs, and removal or replacement conveniently and accessibly with reference to the finished building.

3.5 FLOOR, WALL AND CEILING PLATES

A. Install on piping and ductwork passing through finished walls, floors, ceilings, partitions, and plaster furrings. Plates shall completely cover opening around pipe and duct.

B. Secure wall and ceiling plates to pipe, insulation, or structure.

C. Plates shall not penetrate insulation vapor barriers.

D. Plates not required in mechanical rooms or unfinished spaces.

3.6 PAINTING

A. General: Coordinate painting of mechanical equipment and items with products and methods in conformance with the appropriate Division of Work, Painting. All exposed work under this division shall receive either a factory painted finish or a field prime coat finish, except:

1. Exposed copper piping.

B. Equipment Rooms and Finished Areas:

1. Insulation: Not painted.
2. Hangers, Uninsulated Piping, Miscellaneous Iron Work, Structural Steel Stands, Uninsulated Tanks, and Equipment Bases: Paint one coat of black enamel.
3. Brass Valve Bodies: Not painted.
4. Grilles, Diffusers, Registers: Paint sheet metal and visible ductwork behind grilles, diffusers and registers flat black.

C. Concealed Spaces (above ceilings, not visible):

1. Insulation: Not painted.
2. Hangers, Uninsulated Piping, Miscellaneous Iron Work, Valve Bodies and Bonnets: Not painted.

3.7 ADJUSTING AND CLEANING

A. Before operating any equipment or systems, make thorough check to determine that systems have been flushed and cleaned as required and equipment has been properly installed, lubricated, and serviced. Check factory instructions to see that installations have been made accordingly and that recommended lubricants have been used.

B. Use particular care in lubricating bearings to avoid damage by over-lubrication and blowing out seals. Check equipment for damage that may have occurred during shipment, after delivery, or during installation. Repair damaged equipment as approved or replace with new equipment.

3.8 ELECTRICAL EQUIPMENT

A. Ductwork or piping for mechanical systems not serving electrical space shall not be installed in any switchgear room, transformer vault, telephone room, or electric closet except as indicated.

B. Ductwork or piping for mechanical systems shall not pass over switchboards or electrical panelboards. Where conflicts exist, bring to attention of Architect.

3.9 EQUIPMENT CONNECTIONS

A. Piping:

1. Provide valves and specialties as specified and as detailed on the Drawings. Provide increasers, reducers, and any other fittings required for complete installation.
2. All piping connections shall be independently supported to prevent undue strain on equipment.

END OF SECTION 230500

SECTION 230523 - GENERAL DUTY VALVES AND SPECIALTIES FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The provisions of Section 230500, Common Work Results for HVAC, apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes: Valves, general purpose gauge cocks, and balance fittings.

1.3 SUBMITTALS

A. Submit product data.

B. Submit automatic flow control valve schedule with manufacturer, model, size, flow rate and pressure drop.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURER VALVES

A. General: Where only Nibco figure numbers are listed, equivalent products by those specified below are acceptable.

1. Balancing: DeZurik, Homestead, Bell and Gossett, Armstrong, Walworth, Taco, Wheatley, Tour and Andersson, Victaulic, Gruvlok, and Nibco.
2. Ball: Gruvlok, Apollo, Crane, Hammond, Milwaukee and Victaulic.

B. Other Manufacturers: Submit Substitution Request.

C. All such valves shall be of one manufacturer.

D. Valve ends may be threaded, flanged, soldered, or grooved, as applicable to piping system. Refer to Section 232113 for allowable fittings.

2.2 BALL VALVES

A. Bronze Ball: Bronze cast body or forged brass, chrome-plated full port ball, with handle, Teflon seat, 300 psi WOG, 150 psi steam; Nibco 585-70 or Victaulic Series 589.

2.3 BALANCING VALVE

A. Calibrated:

1. Bronze, Ametal (copper-alloy), or ductile iron body, brass globe or ball, differential pressure readout valves with integral checks, calibrated plate, integral pointer, suitable for tight shutoff, memory stops, threaded, grooved, or soldered ends, 250 psi water; Victaulic, Tour Anderson, Bell and Gossett CB.
2. Size balancing valves based on the published performance curve characteristics for the scheduled flow rate for each location to ensure proper operation at design conditions.

B. Eccentric Plug:

1. Cast iron body, EPT coated plug, pressure measuring ports, flanged or grooved cut end, memory stop, 2-inch square actuating nut for sizes up to 6-inch, above 6-inch gear operator, 175 psi; Victaulic Series 365 or DeZurik 118-F.
2. Size balancing valves based on the published performance curve characteristics for the scheduled flow rate for each location to ensure proper operation at design conditions.

2.4 AUTOMATIC FLOW CONTROL VALVES

A. Acceptable Manufacturers:

1. Griswold, Flow Design, Nexus.
2. Other Manufacturers: Submit Substitution Request.

B. Furnish automatic pressure compensating flow control valves.

C. Valves factory set and calibrated within 5% of indicated water flow rate. Provide taps for measuring of flows with quick disconnect valves.

D. Field adjustable flow rate with adjustable flow control cartridge.

E. Provide identification tags for each valve indicating type, flow characteristics, etc.

F. Pressure range of 1-14 psig.

G. 150 psi operating pressure.

H. Where required, strainers and isolation valves shall be provided separately from flow control valves.

I. Size flow control valves based on the published performance curve characteristics for the scheduled flow rate for each location to ensure proper operation at design conditions.

2.5 SPECIALTY VALVES

A. Gauge Cocks: Brass, tee handle, male to female, 200 psi working pressure, 1/4 inch; Conbraco 41 series.

B. Drain Valves: Bronze globe valve or full port ball valve, garden hose end, cap and chain 3/4 inch size.

2.6 SYSTEM SPECIALTIES

A. Manual Air Vents: Coin type; Dole No. 9 or approved equal.

B. Automatic Air Vents:

1. Acceptable Manufacturers:

   a. Hoffman No. 78, Amtrol, Armstrong, Spirax/Sarco, Spirotop.
   b. Other Manufacturers: Submit Substitution Request.

2. Description: Water main type, cast brass body, built-in check valve, 1/8-inch I.P.S. top tapping for moisture discharge, 3/4-inch size, 150 psi operating pressure.

C. Pressure/Temperature Test Plug:

1. Acceptable Manufacturers:

   a. Peterson Engineering, Inc., Universal Lancaster, Sisco, Trerice.
   b. Other Manufacturers: Submit Substitution Request.

2. General: 1/2-inch N.P.T. fitting to receive either a temperature or pressure probe 1/8-inch O.D., fitted with a color coded and marked cap with gasket.
3. Material: Solid brass with valve core of Nordel.
4. Rating: Minimum 300 psig at 275°F.
5. Gauges and Thermometers: Supply Owner with two pressure gauge adapters with 1/8-inch O.D. probe and two five-inch stem pocket test thermometers 25°-125°F for chilled water, 40°-240°F for heating water.

2.7 INTEGRATED COIL PIPING CONNECTOR

A. Acceptable Manufacturers: Griswold Controls, Flow Design, Nexus.

B. Components shall consist of full port forged brass isolation valves with integral union and pressure temperature port, strainer where indicated, auto flow valve with memory stop, balancing valve, air vents, and drains.

C. Use of integrated flexible braided hoses is not acceptable.

D. Components shall be of same manufacturer as approved assembly supplier listed in this section or other approved manufacturers listed for each component in other sections of this specification.

E. Components shall meet the specifications for each component as listed on other sections of the specification.

F. Assembly shall be capable of continuous operation at 150 psi and system test pressure when installed in piping systems.

G. Assembly shall be the same size as the pipe it connects and have pipe thread connectors on both ends with male or female end adapters as required, except the balancing valve may be a smaller size as required to balance the flow.

2.8 STRAINERS

A. Acceptable Manufacturers:

1. Nibco, Armstrong, McAlear, Sarco, Steamflo, Mueller, R.P. & C. Company Titan Flow Control.
2. Other Manufacturers: Submit Substitution Request.

B. Wye Pattern:

1. Bronze: Bronze body, 250 psi, 1/16-inch perforated type 304 stainless screen.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide valves at connections to equipment where shown or required for equipment isolation.

B. Install all valves and strainers in accessible locations and same size as connected piping (not the size of the equipment connection), except balancing valves shall be sized by the contractor to properly balance the flow.

C. Provide separate support for valves where necessary.

D. Provide drain valves in all low points in the piping system, at coils and equipment, and as indicated.

3.2 APPLIED LOCATIONS HVAC VALVES

A. In piping 2-inches and smaller:

System	Valve Types				
	Gate	**Globe**	**Swing Check**	**Ball**	**Butterfly**
Heating Water	NA	Bronze	Bronze	Bronze	Not Allowed

B. Calibrated balancing valves 2-1/2-inch and smaller, at 3-way water coils and in piping systems in accordance with manufacturer's recommendations.

C. Automatic flow control valves on water coils and in piping systems in accordance with manufacturer's recommendations to automatically balance water flow in piping loops as indicated.

D. Provide gauge cock for all pressure gauges.

3.3 INSTALLATION

A. Manual Air Vents:

1. Install at all high points where automatic air vents are not used, where noted, and where required for proper venting of system.
2. Install in accordance with manufacturer's recommendations.

B. Automatic Air Vents:

1. Install automatic air vents at high points where air can collect in water systems where indicated. Route drain lines from vent to nearest floor drain.
2. Install 3/4-inch globe shut-off valve ahead of air vent. Install ball valve where bucket drainage is required.

C. Test Plugs: Install where indicated and in accordance with the manufacturer's recommendations.

D. Coil Connectors:

1. Applied Locations: Integrated coil connectors are prohibited except where specifically indicated below or on the drawings.
2. Make all connections in accordance with Section 23 21 13, Pipe and Pipe Fittings HVAC.

E. Strainer:

1. Provide valved blow off for each strainer of same size as plugs with maximum size of 1-1/2 inches. Pipe blow off full size and terminate over floor drains except finned tube, reheat coils, fan coils, terminal units, and unit heaters.
2. Applied Locations HVAC:

    a. Bronze wye, in piping 2-inch and smaller.

END OF SECTION 230523

SECTION 230529 - HANGERS, SUPPORTS AND ANCHORS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The provisions of Section 230500, Common Work Results for HVAC apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes: Supports and anchors for piping systems and equipment.

B. Related Sections include:

1. Section 230700 Insulation for HVAC.
2. Section 232113 Pipe and Pipe Fittings HVAC.

1.3 QUALITY ASSURANCE

A. Provide pipe and equipment hangers and supports in accordance with the following:

1. When supports, anchorages, and seismic restraints for equipment, and supports and seismic restraints for conduit, piping, and ductwork are not shown on the Drawings, the contractor shall be responsible for their design.
2. Seismic restraints and anchorages shall resist seismic forces as specified in the latest edition of the International Building Code for the seismic zone in which the project is constructed.
3. Seismic restraint shall not introduce excessive stresses in the piping caused by thermal expansion or contraction.
4. Connections to structural framing shall not introduce twisting, torsion, or lateral bending in the framing members. Provide supplementary steel as required.
5. Seismic restraints shall be in accordance with the latest edition of the SMACNA "Seismic Restraint Manual - Guidelines for Mechanical Systems" for the Seismic Hazard Level corresponding to the seismic zone in which the project is constructed.
6. Seismic restraints shall be in accordance with the applicable code.
7. Seismic restraints shall follow the provisions described in Section 23 05 48, Vibration and Seismic Controls for HVAC Piping and Equipment.

B. Engineered Support Systems: The following support systems shall be designed, detailed, and bear the seal of a professional engineer registered in the State having jurisdiction.

1. Supports and seismic restraints for suspended piping and equipment.
2. Support frames such as pipe racks or stanchions for piping and equipment which provide support from below.
3. Equipment and piping support frame anchorage to supporting slab or structure.

1.4 SUBMITTALS

A. Submit the following:

1. Shop Drawings of contractor fabricated support structures.
2. Structural Details and Calculations: Submit structural details and calculations substantiating that building structure, anchorages, and fabricated steel braces can safely withstand maximum calculated loads.
3. No other submittals required under this section.

PART 2 - PRODUCTS

2.1 SUPPORTS, GENERAL

A. Fabricate support members from welded standard structural shapes, pipe, and plate to carry the necessary rollers, hangers, and accessories as required. Support piping less than 4-inch pipe size from or by prefabricated roll-formed channels with necessary accessories to adequately support piping system.

B. Acceptable Manufacturers: Unistrut, Superstrut, Powerstrut and Kinline, B-Line Systems, AnvilStrut.

C. Supports and Accessories: Preformed roll-formed channels and accessories with matching compatible accessories as shown, as specified, and as required.

D. Dissimilar Metal Protection: Hydra-Zorb cushions or Cush-a-strip.

E. Clamps: Super Strut Series 700 through 702 or AnvilStrut Series 1000 through 1200.

2.2 PIPE ATTACHMENTS

A. Acceptable Manufacturers: Anvil as noted or equivalent products by Superstrut, B-Line Systems, Tolco, Michigan Hanger.

B. Uninsulated Horizontal Copper Piping:

1. 2-inch and Smaller: Anvil CT-65, CT-69, CT-99C.

C. Insulated Horizontal Copper Pipe with Hangers Inside of Insulation: Same as Uninsulated Horizontal Copper Pipe.

D. Other Insulated Horizontal Pipe With Hangers Inside of Insulation:

1. 2-inch and Smaller: Anvil 65, 70, 104, 260 or 300.

2.3 PIPE ROLLERS, INSULATION PROTECTION SHIELDS AND INSULATION PROTECTION SADDLES

A. Acceptable Manufacturers: Anvil as noted or equivalent Super Strut, B-Line Systems, Tolco, Michigan Hangers.

B. Pipe Rollers: Anvil 174 or 274 as required. Size for pipe plus insulation for insulated pipe.

C. Insulation Protection Shields: Anvil 167.

D. Insulation Protection Saddles: Anvil 160 through 166A as required. Saddles for copper pipe, factory or field copper plated.

2.4 BUILDING ATTACHMENTS

A. Acceptable Manufacturers: Anvil as listed or equivalent products by Elcen, Superstrut, B-Line Systems, Tolco, Michigan Hangers.

B. Beam Hangers:

1. On piping 6-inch and smaller: Anvil 86 with retaining clip Fig. 89.

PART 3 - EXECUTION

3.1 HANGERS AND SUPPORTS

A. General:

1. Install all support systems as detailed and in accordance with manufacturer's recommendations. Provide pipe racks, pipe stands, trapeze hangers, etc., as required and as detailed on the Drawings.
2. Provide adjustable hangers for all pipes complete with inserts, adjusters, bolts, nuts, swivels, all-thread rods, etc., except where specified otherwise.
3. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping and do not support piping from other piping.

4. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.
5. Support all piping within 2 feet of each change of direction on both sides of fitting.

B. Insulated Piping Systems:

1. See Section 230700 for insulation requirements.
2. Insulated Piping Systems with Non-Vapor Barrier Insulation:

    a. At the contractor's option, hangers may be installed inside or outside of insulation for piping 2-inch and smaller.
    b. If hangers are installed outside of insulation, provide insulation protection shields at all support locations on piping 1-1/2-inch and larger.

3. Insulation Protection:

    a. Band insulation protection shields firmly to insulation to prevent slippage.
    b. Tack weld insulation protection saddles to steel pipe. Braze saddles to copper pipe.

C. Vertical Piping:

1. Support with U-clamps fastened to wall to hold piping away from wall unless otherwise approved.
2. Risers that are not subject to thermal change to be supported at each floor of penetration.
3. Risers that are subject to thermal change require engineered supports. Size supports to carry all forces exerted by piping system when in operation. Riser supports shall follow the provisions described in Section 230548 Vibration and Seismic Controls for HVAC Piping and Equipment.

D. Horizontal Piping:

1. Trapeze Hangers: Multiple pipe runs where indicated shall be supported on channels with rust resistant finish. Provide all necessary rods and supporting steel.
2. Support Spacing: Provide support at minimum spacing per MSS SP-69-1996 Pipe Hangers and Supports - Selection and Application:

    a. Support piping within 2 feet of each change in direction.
    b. Steel Pipe, Copper Tubing:

Minimum Pipe Size	Max. Span Steel	Max. Span Copper	Rod Size
1-inch and smaller	7 feet	5 feet	1/4-inch
1-1/4-inch to 2-inch	8 feet	8 feet	3/8-inch

E. Building Attachments:

1. Fastening or attaching to steel deck (without concrete fill) is prohibited. It will be necessary to support all piping from structural members, beams, joists, or provide intermediate angle iron supporting members between joists. Supports may be attached to concrete filled steel deck with load limitations shown on the structural drawings or otherwise obtained from the structural engineer.
2. Provide horizontal bracing on all horizontal runs 1-1/2 inch and larger and exceeding 50 feet in length at 75 foot intervals and as required to provide stabilized piping systems.
3. Provide all additional structural steel angles, channels, or other members required to support piping where structures do not occur as required for proper support.
4. Arrange supports to prevent eccentric loading of joists and joist girders. Locate supports at joist panel points.

END OF SECTION 230529

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The provisions of Section 230500, Common Work Results for HVAC apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes: Identify valves, piping and equipment components of the mechanical systems to indicate their function and system served.

1.3 SUBMITTALS

A. Submit the following:

1. Equipment Nameplate Directory: Submit for approval prior to fabrication.
2. Operating and Maintenance Data: Include a copy of valve tag and equipment nameplate directories in each set of Operating and Maintenance manuals.

PART 2 - PRODUCTS

2.1 PIPING MARKERS

A. Acceptable Manufacturers:

1. W.H. Brady, Seton, Marking Systems, Inc. (MSI).
2. Other Manufacturers: Submit Substitution Request.

B. Pipes shall be labeled with all-vinyl, self-sticking labels or letters. For pipe covering sizes up to and including 3/4-inch outside diameter, select labels with 1/2-inch letters. For sizes from 3/4 to 2-inch outside diameter, 3/4-inch letters; above 2-inches outside diameter, 2-inch letters. The pipe markers shall be identified and color coded as follows with black directional arrows.

HVAC SERVICE	BACKGROUND PIPE MARKER *	COLOR
HEATING WATER	"HEATING WATER SUPPLY"	YELLOW OR GREEN
	"HEATING WATER RETURN"	YELLOW
* Directional arrow applied adjacent to pipe marker indicating direction of flow.		

2.2 EQUIPMENT IDENTIFICATION

A. Nameplates:

1. Tag all terminal units with engraved nameplates. Nameplates shall be 1/16-inch thick, 3 x 5 laminated 3-ply plastic, center ply white, outer ply black. Form letters by exposing center ply.
2. Identify unit with equipment tag as shown on Drawings and area served.
3. Access points to fire dampers, smoke dampers, and combination fire and smoke dampers shall be permanently identified on the exterior of the duct by a label with letters 1/2-inch in height reading: Fire Damper, Smoke Damper, or Fire/Smoke Damper, as appropriate. Label constructed from same material as equipment nameplates.

2.3 CONCEALED EQUIPMENT IDENTIFICATION

A. Acceptable Manufacturers:

1. W.H. Brady, Seton.
2. Other Manufacturers: Submit Substitution Request.

B. Adhesive Laminated Tape:

1. 3/4" width transparent clear tape with black lettering.
2. Lettering in ALL CAPS Helvetica font 24 point.

PART 3 - EXECUTION

3.1 PIPING MARKERS

A. Unless recommendations of ANSI A13.1, 1981 are more stringent, apply labels or letters after completion of pipe cleaning, insulation, painting, or other similar work, as follows:

1. Every 20 feet along continuous exposed lines.
2. Every 10 feet along continuous concealed lines.

3. Adjacent to each valve and stubout for future.
4. Where pipe passes through a wall, into and out of concealed spaces.
5. On each riser.
6. On each leg of a "T".
7. Locate conspicuously where visible.

B. Further, apply labels or letters to lower quarters of the pipe on horizontal runs where view is not obstructed or on the upper quarters when pipe is normally viewed from above. Apply arrow labels indicating direction of flow. Arrows to be the same color and sizes as identification labels.

3.2 EQUIPMENT IDENTIFICATION

A. Nameplates: Attach to prominent area of equipment, either with sheet metal screws, brass chain, or contact cement as applicable.

3.3 CONCEALED EQUIPMENT IDENTIFICATION

A. Where valves or equipment are located above ceilings or behind walls provide adhesive tape indicating the item (valve tag, equipment tag, etc.) at the access location (T-bar ceiling grid, access door, etc.).

B. Applicable equipment includes, but is not limited to, the following:

1. Terminal units.

END OF SECTION 230553

SECTION 230590 - PRESSURE TESTING FOR HVAC SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The provisions of Section 230500, Common Work Results for HVAC apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes: Pressure testing of piping and ductwork systems.

1.3 QUALITY ASSURANCE

A. Code Compliance: Perform required tests in the presence of the authority having jurisdiction.

B. Owner Witness: Perform all tests in the presence of the Owner's representative.

C. Engineer Witness: The Engineer or Engineer's representative reserves the right to observe all tests or selected tests to assure compliance with the specifications.

D. Simultaneous Testing: Test observations by the authority having jurisdiction, the Owner's representative and the Engineer's representative need not occur simultaneously.

1.4 SUBMITTALS

A. Submit the following:

1. Test Reports:

    a. Submit certificate of completion, inspection and test by authority having jurisdiction on required piping systems.
    b. Submit certificate of test approval by Owner's representative on all systems.
    c. For ductwork testing, submit the Test Report. Test Report shall contain description of the testing procedure and results, including recommendation for any remedial actions needed. The Engineer's representative will record witnessed tests.

PART 2 - PRODUCTS – NOT APPLICABLE

PART 3 - EXECUTION

3.1 GENERAL

A. Piping: Test prior to concealment, insulation being applied, and connection to equipment, fixtures, or specialties. Conduct tests with all valves but those used to isolate the test section 10% closed.

B. Ductwork: Test prior to connection to equipment and before applying insulation.

C. Leaks: Repair all leaks and retest until stipulated results are achieved.

D. Notification: Advise the engineer 72 hours in advance of each test. Failure to so notify will require test to be rescheduled.

E. Testing Equipment: Provide all necessary pumps, gauges, connections and similar items required to perform the tests.

3.2 TESTING REQUIREMENTS

A. Piping - General: Test all piping as noted below, with no leaks or loss in pressure for time indicated. Repair or replace defective piping until tests are completed successfully:

HVAC Systems	Test Pressure	Test Medium	Test Duration
Refrigerant piping	300 psig	Nitrogen	4 hours
Heating water	150 psig	Water	4 hours

END OF SECTION 230590

SECTION 230593 - TESTING, ADJUSTING AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The provisions of Section 230500, Common Work Results for HVAC apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes:

1. Testing and balancing of air systems.
2. Testing and balancing of hydronic systems.
3. Testing and balancing of miscellaneous mechanical equipment.

B. Related Sections include:

1. Section 230900 Instrumentation and Controls for HVAC.

1.3 QUALITY ASSURANCE

A. Acceptable Testing and Balancing Firms:

1. A.I.R., Inc.
2. Air Balance Specialty, Inc.
3. Neudorfer Engineers, Inc.
4. Northwest Engineering Services.
5. Pacific Coast Air Balance.
6. Accurate Balancing Agency, Inc.

B. Other Firms: Submit Substitution Requests prior to Bid Date.

C. Industrial Standards: Testing and Balancing shall conform to NEBB, American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE), and American National Standards Institute (ANSI) as follows:

1. NEBB: Comply with Procedural Standards for Testing, Adjusting Balancing of Environmental Systems.
2. ASHRAE: Comply with recommendations pertaining to measurements, instruments, and testing, adjusting and balancing.

3. ANSI:

    1. S1.4 Specifications for sound level meters.
    2. S1.11 Specifications for Octave-Band and Fractional-Octave-Band analog and digital filters.

D. Instrument Certification: All instruments used shall be accurately calibrated and certified within six months of balancing and maintained in good working order.

E. Test Observation: If requested, the tests shall be conducted in the presence of the Architect or the Architect's representative.

F. Pre-Balancing Conference: Prior to starting balancing, general techniques shall be reviewed with the Engineer. This conference must occur prior to measuring existing conditions. Measuring of existing conditions must occur prior to any demolition or new work. The conference will review existing conditions and systems to be affected by the project

1.4 SUBMITTALS

A. Submit the following:

1. Balancing Log: Include all air and water outlets, actual field measured air and water volume, and percentage of design volumes. Provide drawings identifying location of all outlets.
2. Equipment Data Sheets: Indicate actual equipment performance, model numbers, bearing and belt data, motor nameplate data, and final balanced motor data.
3. Additional Data: Submit all additional data as provided by Associated Air Balance Council (AABC) Standard forms.
4. Number of Copies: Submit six (6) copies of the above completed information to the Engineer for review and insertion into the Operating and Maintenance Data.
5. Instrument Certification: When requested, submit certificate of calibration for all equipment to be used.

B. Record data on NEBB forms or forms approved by the Architect.

1.5 PROJECT CONDITIONS

A. Where existing systems are to be adjusted, establish flow rates in all branches prior to making any modifications to system. Submit preliminary report indicating existing conditions prior to making any modifications to existing systems. Adjust central equipment as required and restore all unmodified branches and outlets to original condition. Obtain existing system drawings from Owner and become familiar with extent and nature of existing systems.

B. Do not perform final testing, adjusting, and balancing work until heating, ventilating, and air conditioning equipment has been completely installed and operating continuously as required.

C. Conduct air testing and balancing with clean filters in place. Clean strainers, etc., prior to performing hydronic testing and balancing.

1.6 WARRANTIES

A. In addition to the Requirements of the Contract, include an extended warranty of six months after completion of test and balance work during which time the Architect at his discretion may request a recheck or resetting of any equipment or device listed in the test reports.

PART 2 - PRODUCTS – NOT APPLICABLE

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Balance to maximum measured flow. Deviation from specified values of ±10 percent at terminal device and ±5 percent at equipment, or mean sound level deviation of 15 decibels. Advise Engineer if deficiencies are generally noted to enable proper corrective actions.

3.2 AIR SYSTEMS

A. General: Make measurements in accord with Industrial Standards specified above. Record on appropriate forms.

B. Preliminary:

1. Identify and list size, type, and manufacture of all equipment to be tested including air outlets and inlets.
2. Use manufacturer’s ratings for equipment to make required calculations except where field test shows ratings to be impractical.

C. Central System:

1. Set speed to provide air volume at farthest run without excess static pressure. Provide additional sheaves and belts as required to accomplish speed adjustment.
2. Read and adjust air supply, return, and exhaust fan units to deliver design conditions at minimum O.S.A. and at 100% O.S.A.
3. Adjust all automatic dampers, outside air, return air, and exhaust dampers for design conditions.
4. Read static air pressure conditions on all air handling equipment including filter and coil pressure drops and total pressure across the fan. A Dwyer Series 400 air velocity meter only shall be used for final static pressures at equipment and where critical readings are required.
5. Measure temperature conditions across all outside air, return air, and exhaust dampers to check leakage.

6. Read and record motor data and amperage draw.
7. For variable volume systems, establish minimum static pressure required at sensing point to permit operation over entire VAV range. Adjust supply and return fan speed so that at maximum demand the associated VFD is controlling the motor of motor nameplate RPM to 100%. Adjust return fan speed so that return air volumes track with supply air volume minus exhaust air volume.
8. Assist controls contractor in establishing minimum outside air damper positions.

D. Distribution:

1. Evaluate all building and room pressure conditions to determine adequate supply and return air conditions. Generally, the building shall be balanced to be slightly positive to outdoors.
2. Evaluate all building and room pressure conditions to determine adequate performance of the system to maintain temperatures without draft.
3. Perform multipoint pitot traverses to confirm instrumentation, shaft tightness, fan operation, etc. Pitot traverses shall be performed using a Dwyer Series 400 air velocity meter only with applicable duct probe.
4. Mark all balancing dampers.

E. General: Make measurements in accord with Industrial Standards specified above. Record on appropriate forms.

F. Preliminary:

1. List complete data of tested equipment and verify against Contract Documents.
2. Open all line valves to full open position, close coil by-pass stop valves, then set mixing control valve to full coil flow.
3. Verify proper system pressures.
4. Verify air vents in high points of water are properly installed and operating freely.

G. Central Equipment:

1. Check all conditions at all coils for required performance at design conditions.
2. Check conditions at all primary source equipment for performance of design conditions.
3. Read and record pump heads, motor data, and amperage draw.

H. Distribution:

1. Read and adjust water flow for design conditions.
2. Set all memory stops and mark position of adjuster on balancing valves.

3.3 AUTOMATIC CONTROL SYSTEM

A. In cooperation with control manufacturer's representative, set and adjust automatically operated devices to achieve required sequence of operations.

B. Testing organization shall verify all controls for proper calibration and list controls requiring adjustment by control system installer.

3.4 COORDINATION

A. Coordinate work with other trades to ensure rapid completion of the project.

B. Deficiencies noted during the course of air balancing in the mechanical installation shall be promptly reported to the Architect to allow corrective action to proceed.

C. Periodic review of progress shall be provided as requested.

END OF SECTION 230593

SECTION 230700 - INSULATION FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The provisions of Section 230500, Common Work Results for HVAC apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes: Insulation for piping, ductwork (external), ductwork (internal), and equipment.

B. Related Sections include:

1. Section 230529 Hangers, Supports and Anchors for HVAC.
2. Section 233101 HVAC Ducts and Casing – Low Pressure.
3. Section 233102 HVAC Ducts and Casing – Medium Pressure.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements:

1. All insulating products shall be prohibited from containing pentabrominated, octabrominated and decabrominated diphenyl ethers. Where products within this specification contain these banned substances, provide complying products from approved manufacturers with equal performance characteristics.
2. Flame and Smoke Ratings: Installed composite flame spread not to exceed 25 and smoke developed not to exceed 50 as tested by UL 723.
3. Energy Codes: Local Building and Energy Codes shall govern where insulation performance requirements for thickness exceeds thickness specified.

B. Protection: Protect against dirt, water, chemical, or mechanical damage before, during, and after installation. Repair or replace damaged insulation at no additional cost.

C. Source Quality Control:

1. Service: Use insulation specifically manufactured for service specified.
2. Labeling: Insulation labeled or stamped with brand name and number.
3. Insulation and accessories shall not provide any nutritional or bodily use to fungi, bacteria, insects, rats, mice, or other vermin, shall not react corrosively with equipment, piping, or ductwork, and shall be asbestos free.

1.4 SUBMITTALS

A. Submit the following.

1. Product Data: For each type including density, conductivity, thickness, jacket, vapor barrier, and flame spread and smoke developed indices.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Equivalent products by Johns Manville, Knauf, Owens Corning, and CertainTeed are acceptable.

B. All such insulation shall be of one manufacturer.

C. Other Manufacturers: Submit Substitution Request.

2.2 PIPE INSULATION

A. Fiberglass: Split sectional or snap-on type with 0.23 per inch maximum thermal conductivity (K-factor) at 75°F mean temperature, 850°F maximum service rating and white, vapor barrier jacket with pressure sensitive closure system. Johns Manville Microlok HP.

B. Calcium Silicate: Sectional with 14 pcf nominal density, 0.40 maximum K-factor at 300°F mean temperature and 1200°F maximum service rating. Johns Manville Thermo-12 Gold.

2.3 BLOCK INSULATION

A. Calcium Silicate: 1-1/2-inch thick unless specified or shown otherwise with 14 pcf nominal density, 0.40 maximum K-factor at 300°F mean temperature and 1200°F minimum operating temperature limit. Johns Manville Thermo-12 Gold.

B. Fiberglass: 1-1/2-inch thick unless specified or shown otherwise with 3 pcf nominal density, 0.23 per inch maximum K-factor at 75°F mean temperature and 450°F minimum operating temperature limit. Johns Manville 1000 Series.

2.4 DUCTWORK BLANKET INSULATION

A. Fiberglass: 1.0 pcf nominal density, 0.25 per inch maximum K-factor at 75°F mean temperature, 250°F minimum operating temperature limit. Johns Manville Microlite Type 100 with facing as follows:

1. Exposed: FSK facing (foil scrim Kraft) or vinyl - white appearance.
2. Concealed with Vapor Barrier: FSK reinforced foil and paper.
3. Concealed without Vapor Barrier: Facing not required.

B. Semi-Rigid Fiberglass: 2.5 pcf nominal density, 0.24 per inch maximum K-factor, at 75°F mean temperature, 250°F minimum operating temperature limit. Johns Manville Micro-Flex with facing as follows:

1. Exposed: FSK facing (foil scrim kraft) or vinyl-white appearance.
2. Concealed with Vapor Barrier: FSK reinforced foil and paper.
3. Concealed without Vapor Barrier: Facing not required.

2.5 DUCT INSULATION, INTERNAL

A. Description: Fiberglass with airstream surface protected with a glass mat facing that contains an EPA registered anti-microbial agent proven to resist microbial growth as determined by ASTM G21 and G22, 1-inch thick unless indicated otherwise. 2-inch thick insulation shall have 0.24 per inch maximum K-Factor at 75°F mean temperature. Johns Manville Duct Liner PM for rectangular ductwork.

B. Acoustical Absorption Coefficients: With minimum NRC of 0.70 for 1-inch and 0.90 for 2-inch as tested in accordance with ASTM C-423-90, type A mounting.

C. Liner must meet ASTM C1071.

2.6 ACCESSORIES PIPING

A. Adhesives:

1. Fiberglass: Zeston Z-Glu.
2. Calcium Silicate: Benjamin Foster 30-36.

B. Cements:

1. Insulating: Ryder.
2. Heat Transfer: Zeston Z-20.

C. Wire Mesh: 1-inch mesh with 20 gauge annealed steel wire.

D. Pipe Fitting Covers: One piece PVC insulated pipe fitting covers. Zeston, Ceel-Co.

E. Cloth Facing: Presized fiberglass cloth.

F. Tapes: Pressure sensitive, weather resistant, and for temperatures up to 150°F. Zeston Z-tape.

2.7 ACCESSORIES DUCTWORK

A. Adhesives:

1. Fiberglass: Zeston Z-Glu.
2. Duct Insulation, Internal: Benjamin Foster 85-20.

B. Weld Pins: Duro-Dyne with NC-1 nylon stop clips.

C. Cements:

1. Insulating: Ryder.
2. Heat Transfer: Zeston Z-20.

D. Wire Mesh: 1-inch mesh with 20 gauge annealed steel wire.

E. Mastic: Chicago Mastic:

1. Vapor Barrier: 17-475.
2. Outdoor Mastic: 16-110 white.

F. Cloth Facing: Presized fiberglass cloth.

G. Tapes: Pressure sensitive, weather resistant, and for temperatures up to 150°F. Zeston Z-tape.

PART 3 - EXECUTION

3.1 GENERAL

A. Workmanship:

1. Installation: Insulation installed in first class, neat professional manner.
2. Applicators: Applicators shall be employed by firm that specializes in insulation work.

B. Preparation: Surfaces of piping and ductwork clean, free of oil or dirt, and dry before insulation is applied.

C. Stamps: ASME stamps, UL labels, and similar stamps and labels shall not be covered.

3.2 HVAC PIPE INSULATION APPLIED LOCATIONS

A. Insulation Applied Locations – HVAC Piping:

System	Pipe Size	Insulation Type	Insulation Thickness
Heating Water (to 250°F)	1 1/4-inch and smaller	Fiberglass	2-inch
	1 1/2-inch to 6-inch	Fiberglass	2 1/2-inch

B. Insulation shall include all fittings, unions, flanges, mechanical couplings, valve bodies, valve bonnets, piping through sleeves.

C. Piping insulation is not required between the control valve and coil on run-outs when the control valve is located within 4 feet of the coils and the pipe size is 1-inch or less.

D. Valves and irregular fittings shall be insulated with section of pipe insulation and insulating cement, securely fastened, and finished with 6 oz. canvas and Foster 30-36 lagging adhesive.

3.3 PIPING INSTALLATION

A. General:

1. Joints: Coat both sides of complete joining area with applicable adhesive.

    a. Longitudinal Joints: Make joints on top or back of pipe to minimize visibility.
    b. Butt Joints: Butt lightly together and, seal with 3-inch wide tape or butt straps.
    c. Multiple Layered Insulation: Joints staggered.

2. Access: Strainer and other items requiring service or maintenance with easily removable and replaceable section of insulation to provide access.
3. Voids: Fill all voids, chipped corners and other openings with insulating cement or material compatible with insulating material. In insulation with Heat Tracing: Where piping is shown or specified to be heat traced, bed heat tape into heat transfer cement with insulation over heat tape and cement.
4. Seal joints, seams and fittings of metal watertight jackets at exterior locations.

B. Fiberglass Insulation: Exterior insulation encased in metal jacket.

C. Calcium Silicate Insulation:

1. Secure with 18-gauge wire embedded into insulation.
2. Cover with cloth facing secured with applicable adhesive.

D. Fittings:

1. Fittings covered with insulation to the same level of the adjoining insulation or fill with insulating cement. Finish with pipe fitting covers or cloth facing and tape.

E. Unions, Mechanical Joints, Valves, Etc.:

1. General:

a. As specified for fittings.
b. Minimum thickness same as specified for piping.

2. Unions: Build up insulation at least 1/2-inch beyond adjoining insulation.

F. Non-Vapor Barrier Insulation:

1. Refer to Section 230529 for support requirements.
2. At contractor's option, insulation may be interrupted at supports. Butt insulation tight to support.
3. If contractor elects to continue insulation at supports, installation as specified for piping systems with vapor barrier installation.
4. Void between saddle and pipe filled with insulation.

3.4 DUCT INSULATION APPLIED LOCATIONS

A. General:

1. All external insulation with continuous vapor barriers unless specifically noted otherwise.
2. Internally lined shall be lined completely to grille or diffuser or to indicated terminal points. Dimension shown are net inside of liner.
3. Internally lined ductwork need not be externally insulated.
4. In addition to locations described in specification, internally line medium, low, return and exhaust air ductwork where shown on drawings.

B. Insulation Applied Location – HVAC Ductwork:

System	Location	Duct Type	Insulation Type	Thickness	Notes
Medium Pressure Supply*	Exposed or Visible (Including above a cloud ceiling)	Rectangular	Internally Lined	1 1/2-inch	
		Round/Oval	Internally Lined	1 1/2-inch	Note 3
	Concealed or in mechanical rooms	All	Fiberglass Blanket	1 1/2-inch	
	15 ft upstream and downstream of fans	All	Internally Lined	1 1/2-inch unless otherwise indicated	Note 3
Low Pressure Supply*	Exposed or Visible (Including above a cloud ceiling)	Rectangular	Internally Lined	1 1/2-inch	
		Round	Internally Lined	1 1/2-inch	
	Concealed or in mechanical rooms	All	Fiberglass Blanket	1 1/2-inch	
	15 ft upstream and downstream of fans	All	Internally Lined	1 1/2-inch unless otherwise indicated	
Return Air* (Not insulated except:)	15 ft upstream and downstream of fans	All	Internally Lined	1-inch unless otherwise indicated	
Exhaust Air* (Not insulated except:)	15 ft upstream and downstream of fans	All	Internally Lined	1-inch unless otherwise indicated	
	In Toilet Rooms, 10 ft downstream of exhaust grilles	All	Internally Lined	1-inch	
Transfer Air	All	All	Internally Lined	1-inch	

* In addition to applied locations listed in this table, provide internally lined ductwork where indicated on drawings.
Note 2: Insulation not required on factory fabricated insulated housings and plenums (AHP).
Note 3: Where round or oval ductwork is indicated, provide double walled as specified in 23 31 02.
Note 4: Use semi-rigid blanket for galvanized sheet metal duct and use semi-rigid board for stainless steel duct.

3.5 DUCTWORK INSTALLATION

A. General:

1. Install in accordance with manufacturer's instruction.
2. The vapor barrier shall be continuous. Tears, holes, staples, etc. shall be coated with vapor barrier mastic and patch with facing or tape. Joints between insulation and access with vapor barrier mastic.
3. Insulation at access panels to be removable or attached to panel with edges of panel and opening reinforced with metal beading.

B. External Blanket Insulation:

1. Insulation secured to ductwork with 20-gauge snap wires 24 inches on center and at all joints.
2. Joints and seams lapped a minimum of 3 inches and sealed with jacket tape.

C. Internal Duct Liner:

1. The coated surface shall face air stream.
2. Weld pins spaced maximum of 15-inch on center in both directions and within 2 inches of all corners and joints. Weld pins flush with liner surface.
3. Complete duct surface coated with adhesive and insulation pressed tightly thereto.
4. Edges at terminal points shall be provided with metal beading and heavily coated with adhesive.
5. All joints and corners shall be heavily coated with adhesive.
6. Damaged areas replaced or heavily coated with adhesive.

D. Volume Dampers: Where volume dampers do not allow for continuous insulation, terminate insulation clear of handle sweep and finish edges to maintain vapor barrier and to prevent damage to the insulation.

3.6 FIELD QUALITY CONTROL

A. Field Test: All systems shall be tested and approved prior to installation of insulation.

B. Existing Insulation:

1. Repair existing insulation damaged during construction.
2. Make neat connections where new and existing insulation meet.
3. Where existing piping, ductwork or equipment is removed, cover existing surfaces neatly to match existing.
4. Where existing insulation is damaged or missing, notify the architect prior to performing to work.

END OF SECTION 230700

SECTION 230900 - INSTRUMENTATION AND CONTROLS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The provisions of Section 230500, Common Work Results for HVAC apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes: Provide complete automatic control system.

B. Related Sections include:

1. Section 220593 Testing, Adjusting and Balancing for Plumbing.
2. Section 232113 Pipe and Pipe Fittings HVAC.
3. Section 230593 Testing, Adjusting and Balancing for HVAC.
4. Section 230993 Sequence of Operation for HVAC Controls.

1.3 QUALITY ASSURANCE

A. Control work shall be provided by single company with specialists in the type of work required, so that only one control manufacturer is responsible for all control and automation work for project.

B. Provide coordination with other contractors or subcontractors for work required by other trades for accomplishment of control work.

C. Prior to substantial completion, controls contractor must demonstrate to Owner that system is operating per the Specifications and final adjustments have been made as approved.

D. System, including all components and appurtenances, shall be configured and installed to yield a Mean Time Between Failure (MTBF) of at least 1,000 hours.

1.4 SUBMITTALS

A. System Drawings: The submittals shall be prepared on AutoCad format and shall include the following:

1. Equipment installation, block diagrams, and wiring diagrams.
2. DDC panel physical layout and schematics.
3. Sensor and control wiring and installation drawings which identify each component and show all interconnected or interlocked components.
4. Material and equipment descriptive material such as catalog cuts, diagrams, performance curves, and other data to demonstrate conformance with specifications.
5. Details of connections to power sources, including grounding.
6. Details of surge protection device installations.
7. Instrumentation and control diagrams.
8. Complete a written description of control sequences.
9. List of connected data points, including DDC panels to which they are connected, and input device (sensor, etc.).
10. Valve and damper schedules indicating flows, pressure drops, CV's, and actuator type.

B. Equipment Data: The submittals shall include complete data for all materials, including field and system equipment.

C. Software Data: The submittals shall consist of complete descriptions of system, command, and applications software as specified. Include description of control sequences which are software based using detailed logic flow diagrams. Diagrams shall indicate logic used to achieve control sequence of calculation specified, and shall show relationship between control sequence and application software packages specified.

D. Testing Submittals: Provide test plan and test procedures for approval. Explain in detail, step-by-step, actions and expected results to demonstrate compliance with the requirements of this specification and methods for simulating necessary conditions of operation to demonstrate performance of the system. Test plan and test procedures shall demonstrate capability of system to monitor and control equipment and to accomplish control and monitoring specified.

E. Operation and Maintenance Manuals: Provide three complete sets of manuals bound in loose-leaf binders within 30 days after completing acceptance tests. Identify each manuals contents on cover. Manuals shall include names, addresses, and telephone numbers of each subcontractor installing equipment and systems, and of nearest service representatives for each item of equipment and each system. Place tab sheets at beginning of each chapter or section and at beginning of each appendix. Final copies delivered after completion of the acceptance tests shall include all modifications made during installation, checkout, and acceptance. Operation and Maintenance Manuals to include hardware manual, software manual, operations manual, and maintenance manual.

1. Hardware Manual: Furnish a hardware manual describing all equipment provided, including:

a. General description and specifications.
b. Installation and checkout procedures.

c. Equipment electrical schematics and layout drawings.
d. System schematics and I-O wiring lists.
e. Alignment and calibration procedures.

2. Software Manual: The software manual shall describe all furnished software. The manual shall be oriented to programmers and shall describe calling requirements, data exchange requirements, data file requirements, and other information necessary to enable proper integration, loading, testing, and program execution. Provide one software manual per Operator's Terminal.
3. Operator's Manual: The operator's manual shall provide all procedures and instructions for operation of the system, including:

a. DDC panels and peripherals.
b. System start-up and shutdown procedures.
c. Use of system, command, and applications software.
d. Alarm presentation.
e. Recovery and restart procedures.
f. Report generation.
g. System schematic graphics.
h. Provide one Operator's Manual per Operator's Terminal.

4. Maintenance Manual: The maintenance manual shall provide descriptions of maintenance for all equipment including inspection, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective components.
5. Acceptance Test Forms: Maintenance manual shall include copies of signed-off acceptance test forms.

1.5 ACCEPTANCE TESTING AND TRAINING

A. Site Testing:

1. General: Contractor shall provide all personnel, equipment, instrumentation, and supplies necessary to perform testing. Owner or Owner's representative will witness and sign off on acceptance testing.
2. Acceptance Test: Contractor shall demonstrate compliance of completed control system with contract documents. Using approved test plan, all physical and functional requirements of project shall be demonstrated.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS/INSTALLERS

A. Acceptable Manufacturers/Installers:

1. Trane by Trane Oregon

2.2 SYSTEM DESCRIPTION

A. General:

1. Provide modifications to and extension of the existing Trane Tracer Summit DDC system to
2. Provide all equipment, installation, wiring and accessories as required but not necessarily specified to accomplish operations as described.

2.3 MATERIALS AND EQUIPMENT

A. Controls and Power Wiring:

1. General: Electric equipment and wiring shall be in accordance with Division 26. Manual or automatic control and protective or signal devices required for operation specified, and any control wiring required for controls and devices, shall be provided hereunder.
2. Wiring:

    a. Field and Subfield Panels: Voltage in panels shall not exceed 120 volts. Where devices are wired to higher voltages, mount in suitable individual enclosures or group in separate control panel. Coordinate electrical power supply with Division 26.
    b. Motor Control Centers: Responsibility for correct voltage of holding coils and starter wiring in pre-wired motor control centers interfacing with automatic controls is included hereunder.
    c. Wiring for DDC systems communications buses shall be two conductor minimum 18 gauge foil-shielded, stranded twisted pair cable rated at 300 VDC or more than 80°C.

B. Control Panels:

1. Wall mounted control panels shall be provided as required to contain all relays, terminal strips, power supplies and other equipment in building control system.
2. Panels shall be U.L. listed, minimum NEMA 1, minimum 14 gauge steel with stiffeners, continuous hinge doors, locking handles, single point latch.

2.4 CONTROL DEVICES

A. Temperature Instruments:

1. Room Temperature Sensors: Thermistor type with accuracy of ±0.4°F at 70°F; operating range 30-120°F; linear to DDC system; single point sensing element in wall-mounted enclosure with insulating backplate if mounted on exterior wall.

    a. Sensor shall not have digital readout display.
    b. Sensor shall have user adjustment based on DDC programmed offset.

2. Duct Temperature Sensors: Thermistor element with accuracy of ±0.5°F at 32°F, averaging type consisting of array of single point sensing elements, securely mounted in duct or plenum; operating range 0-100°F; linear signal; 20-foot element.
3. Low Temperature Limit Thermostat: Minimum 20 foot capillary sensing element, triggering on low temperature as sensed by any 6-inch segment; snap acting, normally open contacts, manual reset, line voltage.

B. Motorized Valves: Equip with equal percentage with tight shutoff. Two position valves shall be line size (two position ball valves shall be full port), modulating water valves shall be sized at 5 psi drop or as shown on the Drawing. Screwed ends except 2-1/2-inch and larger valves with flanged ends. Select valves to modulate smoothly at all system pressures and flows. Select valves with close-off ratings and spring ranges designed to operate at the maximum flows and maximum available pump heads scheduled without leakage. Bubble tight butterfly valves acceptable on 2-1/2-inch lines and above for two-position action only. Air handling unit heating and cooling coil valves shall be sized for 5 psi drop, unless otherwise noted on drawings.

C. Valve Operators:

1. Electronic modulating actuators with low voltage DC or current positioning signal. Each actuator shall have current limiting circuitry incorporated in its design to prevent damage to the actuator. Modulating actuators shall be provided and shall accept 0-10 VDC or 2-10 VDC or 4-20 mA input signal. Actuators shall provide the minimum torque required for proper close-off against the system pressure for the required application. The spring return feature shall permit normally open or normally closed positions of the valve. All direct shaft mount rotational actuators shall have external adjustable stops to limit the travel in either direction. Actuators shall be powered by 24 VAC.

D. Duct Static Pressure Transmitter: Operating range 0 to 5 inches WC for duct mounted transmitter and 0 to 5 inches WC for fan high limit transmitters. Sensors either diaphragm or rigid element bellows, electronic type. Each transmitter shall be provided with stop cock and tubing for attacking portable pressure gauge. Sensing tube securely mounted in duct with appropriate fitting. Accuracy ±1% of span, maximum response time 1 second.

E. VAV Actuators: All actuators shall be proportional 24 VAC actuators using floating point control. Zero out floating point control daily. Actuators shall stop automatically at end of travel and shall include a permanently lubricated gear train. Actuators shall be furnished by the controls manufacturer and factory installed and tested by the terminal unit manufacturer.

F. Carbon Dioxide Sensor: Infrared sensing, Carbon Dioxide gas monitor. Based on Airtest TR9290 series.

Detection Range:	0-2000ppm
Accuracy:	+/- 3% of measured value
Response Time:	2 minutes
Outputs:	0-10V, 4-20mA
Calibration:	Self calibrating, calibration not required
Power Requirement:	24 VAC/VDC ±20%, 50-60Hz (half-wave rectified)
Operating Temperature Range:	32°F to 122°F
Operating Humidity Range:	0% - 95% RH, Non-Condensing
Display:	Sensor shall be provided with digital display.

2.5 DDC FIELD PANELS

A. Multipurpose Controllers:

1. Multipurpose controllers shall be stand alone microprocessor based panels, enclosed in sturdy metal enclosure with two standard RS232 interface ports, network communications module, power supply, and battery back-up.
2. Panels will be used to connect field sensors and control devices. Each panel shall be fully supervised to detect failures. Construct panel so that all functions are implemented on replaceable circuit boards to permit field maintenance. Panels shall be completely field programmable through portable terminal. Each DDC panel is to have minimum 8-hour battery backup system.
3. Each DDC panel shall be linked with data trunk cable to other controllers and Operator's Terminals to distribute information. Field panels shall continuously exchange data through trunk cable without requiring output to input wiring between panels. The system shall be arranged so that all operations are maintained without the central computer being connected to the system.
4. Upon failure of the DDC field panel, including transmission failure, the panel shall automatically force the controls to remain in the last command status.
5. Provide a real time clock with calendar maintaining seconds, minutes, hours, and days of the week, accurate to ±10 seconds per day.
6. Provide sufficient memory to perform all specified and shown DDC field panel functions and operations, including all spares. Each DDC panel to have 10 percent minimum spare memory board spacing.
7. Each DDC field panel shall contain hardware to support power fail automatic restart.
8. Provide locking type mounting cabinets with common keying.
9. DDC field panel shall have built-in diagnostics to display to operator interface terminal any sensor transmitting signal out of its design range.
10. All control logic shall be done with software resident in each local DDC panel. Auxiliary relays may be used only when required for load contact rating.
11. Panels shall be U.L. listed.

B. Terminal Equipment Controller:

1. Terminal equipment controllers shall be provided for each piece of equipment as specified and shall include all point inputs and outputs as necessary to perform specified control sequences.
2. Each controller performing space temperature control shall be provided with a matching room temperature sensor, which shall include terminal jack to monitor all hardware and software associated with controller.
3. Each room sensor shall include setpoint adjustment dial, temperature indicator and override switch. Override switch shall override night setback mode to normal (day) mode when activated by occupant. Adjustment dial and override switch may be locked out, overridden, or limited through software from central work station or portable terminal.
4. Each controller shall be independent of other network communications. Controller shall receive real time data from central work station or multipurpose controller.
5. Controller shall utilize proportional, integral, and derivative (PID) algorithms which shall be field adjustable.
6. Data base and sequence of operation programs shall be stored in non-volatile EEPROM and EPROM.
7. Controllers shall be networked through communications link to the Multipurpose controller.
8. Controllers shall be powered from 24 VAC source. Provide dedicated power source. Coordinate with Division 26.
9. VAV box controllers shall include differential pressure transducer connected to manufacturers standard velocity sensor, and shall include provisions for both automatic and manual calibration of transducer to ensure against drift. Controller shall incorporate algorithm to allow for modulation of hot water heating valve. Fan powered terminal units shall control series or parallel fan as appropriate. Provide fan status proof current switch.

2.6 INPUT/OUTPUT (I/O) FUNCTIONS

A. Analog Inputs (AI): The AI function shall monitor each analog input, perform A-to-D conversion, and hold the digital value in a buffer for interrogation. Provide signal conditioning for each analog input. Individually calibrate all analog inputs for zero and span, in hardware or in software. Minimum 12 bit A to D resolution.

B. Analog Outputs (AO): The AO function shall accept digital data, perform D-to-A conversion, and output a signal compatible with the operator. Individually calibrate all analog outputs for zero and span. Provide short circuit protection. Minimum 8 bit D to A resolution.

C. Digital Inputs (DI): The DI function shall accept on/off, open/close, or other change of state (two-state data) indications. Provide isolation and protection against input voltage up to 180 Vac peak.

D. Digital Outputs (DO): The DO function shall provide contact closures for momentary and maintained operation of output devices. Closures shall have a minimum duration of 0.1 second.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Mounting Panels: Locate panels where shown on Drawings or near item of equipment to be controlled, but not on equipment itself.

B. DDC Field Panels: Provide number of panels required to accommodate all DI, DO, AI, and AO points and all hardware and software to accomplish specified control sequenced. Locate all panels in mechanical or electrical rooms. Submit proposed locations for approval prior to preparing control drawings.

C. Pneumatic Signals: The use of pneumatic signals to start and stop motors is not allowed.

D. Electrical:

1. Provide control wiring for all control devices and control panels.
2. Run all control wiring in mechanical rooms or locations susceptible to damage in conduit. Plenum rated cable may be used in other locations.
3. Provide power wiring for all control devices and control panels. Utilized designated circuits in electrical power panels. Refer to Electrical Drawings. If no circuits are designated for DDC Controls, submit detailed request for use of spare circuits at no additional cost.
4. All power wiring to be installed in conduit.
5. Grounding: Instrumentation and communication grounding shall be installed as necessary to preclude ground loops, noise, and surges from adversely affecting system operation.
6. Control voltage shall be limited to maximum of 120 volts.
7. Where relay coil is connected to load side of motor starter to energize with motor operation, external control circuit shall be properly fused with fuse block located in respective starter enclosure.
8. Where relays are used to control single phase motors directly, provide contacts rated for not less than horsepower rating of largest motor switched by relay.

E. Identification: Provide engraved nameplates identifying all switches, lights and starters, and each control device where control function is not readily apparent.

F. Room Thermostats and Room Sensors:

1. Wall Thermostats and Room Sensors with User Adjustment: Mount at height of 48 inches above finished floor.
2. Wall Thermostats and Room Sensors without User Adjustment: Mount at height of 60 inches above finished floor.
3. Provide insulating back on thermostats mounted on exterior walls.
4. Provide one thermostat for each zone of temperature control.
5. Submit proposed locations for approval prior to preparing control drawings, where not shown or alternate location is proposed.

G. Carbon Dioxide Sensor:

1. Mount sensor at 5 feet above finished floor or as indicated on the plans.
2. Provide sensor quantity as indicated on plans or as required by sensor coverage rating (max. 20-foot radius).
3. Alarm above 850 PPM.
4. Refer to sequence of operations for more information on sensor use.

H. Provide Current Transformers sized based on minimum circuit ampacity listed on equipment nameplate or circuit overcurrent protection device rating.

I. Provide Current Transformer conductors sized per manufacturer's published requirements based on length of run.

J. Provide additional NEMA enclosures as necessary for Current Transformers in order to provide manufacturer recommended clearances between separate Current Transformers.

K. All instrumentation shall be calibrated based on National Institute of Standards and Technology, NIST, procedures.

END OF SECTION 230900

SECTION 230993 - SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. This Section includes control sequences for HVAC systems, subsystems, and equipment.

1.2 RELATED WORK

A. This Section shall be used in conjunction with the following other specifications and related Contract Documents to establish the total requirements for the system.

1. Section 230593 Testing, Adjusting & Balancing.
2. Section 230900 Instrumentation and Controls for HVAC.
3. Section 233600 Air Terminal Units.
4. Caution: Use of this Section without including all of the above-listed items will result in omission of basic requirements.

1.3 SUBMITTALS

A. Reference Section 230900, Instrumentation and Controls for HVAC, for required submittals.

1.4 GENERAL REQUIREMENTS

A. General

1. Sequences of Operation for all equipment are described in PART 2 – SEQUENCES OF OPERATION below.
2. All system functions and operations shall be accomplished by the DDC controller, except where explicitly defined as hard-wired, stand-alone, or factory-installed equipment controls.
3. Where factory-installed equipment controls are furnished as specified under other Sections, install and wire all switches, sensors, accessories and other control devices and wiring required for a complete operational system. Set up and adjust all controls to perform the sequences described below.
4. Refer to Section 230900 Instrumentation and Controls for HVAC for information on valves, including type, configuration and de-energized position.
5. Provide all devices, materials, equipment, software, wiring, labor and engineering necessary to achieve the Sequences of Operation described in Part 2 below.

PART 2 - SEQUENCES OF OPERATION

2.1 VARIABLE VOLUME AIR HANDLING SYSTEM – TERMINAL UNITS

A. System Level Sequence:

1. System Equipment:

a. Air Handling Unit – Existing, no change to sequence except for addition of demand control ventilation
b. Series Fan-Powered Variable Air Volume Terminal Unit (FPS)

B. Existing Packaged Air Handling Unit

1. Occupied Cycle:

a. General: The Air Handling Unit shall operate in the Occupied Cycle as currently programmed except as follows:

1) Minimum Outside Air Control: When the Outside Air Damper is at its minimum position, modulate the Return Damper to maintain the static pressure setpoint (adjustable) in the mixed air plenum. Coordinate with the air balancing subcontractor to determine the minimum position of the Outside Air Damper and the static pressure setpoint to maintain the required minimum outside air quantity.
2) When the Air Terminal Units have fully reset their minimum CFM setpoints (see Air Terminal Units sequence below), reset the minimum outside air CFM setpoint (adjustable) between its minimum and maximum limits (adjustable) to maintain the CO2 differential as measured by CO2 sensors at interior locations shown on the Drawings. The CO2 differential setpoint shall be equal to a value 500 PPM (adjustable) greater than the CO2 level in the outside air.

C. Series Fan-Powered Variable Volume Air Terminal Unit (FPS):

1. General

a. Pressure Independence: Counteract changes in airflow caused by system pressure changes by monitoring static and velocity pressure at Air Terminal Unit inlet and adjusting the Damper position accordingly.
b. Airflow Measurement: Calibrate controller using manufacturer’s data to provide correct reading of airflow through Air Terminal Unit. Provide auto-recalibration sequence to maintain accuracy.

2. Air Terminal Unit Scheduling

    a. The Air Terminal Unit shall follow the schedule of the associated Air Handling Unit.

3. Unoccupied Cycle

    a. The Unoccupied Cycle shall be identical to the Occupied Cycle, with the following exceptions:

        1) Space temperature setpoints shall be 60 °F (heating, adjustable) and 85 °F (cooling, adjustable).

4. Occupied Cycle

    a. Space temperature setpoints (adjustable) shall be 75 °F for cooling and 70 °F for heating.

5. Series Fan-Powered Variable Volume Air Terminal Unit

    a. Unoccupied Cycle Operation: The Unoccupied Cycle shall be identical to the Occupied Cycle below with the following exceptions:

        1) The Fan shall operate only when there is a call for heating or cooling, and the Air Handling Unit is operating.
        2) The cooling minimum CFM shall be zero.
        3) When the Air Handling Unit is supplying heated air, the Damper shall be modulated to maintain the space temperature setpoint. The heating maximum CFM shall be equal to the scheduled cooling maximum CFM.

    b. Occupied Cycle Operation:

        1) The fan shall operate continuously.
        2) Modulate the Damper to vary the primary airflow between its cooling maximum (adjustable) and cooling minimum (adjustable) to maintain the temperature setpoint (adjustable) at the space temperature sensor.
        3) Units With Heating Water Coils: When the primary airflow has reached its scheduled cooling minimum CFM and the space temperature remains below setpoint, the Heating Water Coil Valve shall be modulated to maintain the required space temperature setpoint.

6. Minimum CFM Reset (Demand Based Ventilation): Monitor CO2 sensors located in the interior locations shown on the Drawings. Reset the minimum CFM as follows:

    a. For spaces with CO2 sensors the minimum primary CFM shall be reset between the scheduled High Minimum CFM and the scheduled Low Minimum CFM as required to maintain the differential CO2 level setpoint (adjustable).

7. Shutdown Mode

    a. The Damper shall be open.
    b. The Heating Coil Valve shall be closed.
    c. The Fan shall not operate.

8. Additional Points For Monitoring Only: Monitor the following additional points not required for control sequences:

    a. Air Terminal Unit discharge air temperature

9. Alarms/Safeties:

    a. Fan Failure Alarm: Generate an alarm in the event of Fan failure as sensed by current transformer switch located in the fan power circuit.
    b. Space Temperature Alarm: Generate an alarm in the event the space temperature deviates from the currently scheduled setpoint by more than the specified amount (adjustable).
    c. Indoor Air Quality: Generate an alarm in the event the indoor CO2 concentration at any CO2 sensor exceeds the setpoint by greater than 10% (adjustable).

END OF SECTION 230993

SECTION 232113 - PIPE AND PIPE FITTINGS HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The provisions of Section 230500, Common Work Results for HVAC apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes: Furnish piping, pipe fittings, and incidental related items as required for complete piping systems, and treatment of HVAC water systems.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Piping material and installation to meet requirements of the local building codes and serving utility requirements.

B. Pipe Cleaning: Should any pipe be plugged or should foaming of water systems occur, disconnect piping, re-clean, and reconnect without additional expense to the Owner.

C. Correct any damage to the building or systems resulting from failure to properly clean the system without additional expense to the Owner.

1.4 SUBMITTALS

A. Submit the Following:

1. List of piping materials indicating the service it is being used for. (Do not submit piping product data).
2. Certificate of completion
3. Treatment Reports

B. Test Reports and Certificates: Submit certificates of inspections and pipe tests to Owner.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. As indicated.

2.2 COPPER PIPE

A. Pipe: Hard drawn copper tubing, Class L, ASTM B 88.

B. Fittings:

1. Wrought copper, 150 psi; ANSI B16.22 for soldered joints, ANSI B16.50 for brazed joints; Chase, Revere, Mueller or approved equal.

C. Service:

1. Refrigerant piping (Type L, hard drawn, ACR cleaned).
2. Heating water piping (Type L, hard drawn) up to and including 2-inches.

2.3 PVC PIPE

A. Pipe: Schedule 80 PVC, normal impact, Type 1, ASTM D 1785.

B. Fittings: Schedule 80 PVC, deep socket, solvent welded, ASTM D2467.

C. Service:

1. Coil condensate drains and traps.
2. Except not allowed in return air plenums.

2.4 UNIONS

A. 200 psi WOG bronze, ground joint, solder type for copper tubing.

B. Dielectric fittings shall be nationally listed, have a dielectric thermoplastic interior lining, and meet requirements of ASTM F-492. Fittings shall be suitable for the pressure and temperature to be encountered.

2.5 SOLDERING AND BRAZING

A. Brazed Joints:

1. Westinghouse Phos-Copper or Dyna-Flow by J.W. Harris Co., Inc.
2. Applied locations:

1. Refrigerant piping. Braze in accordance with Copper Development Association Copper Tube Handbook using BCUP series filler material.

B. Soldered Joints:

1. Wrought Copper Pipe Fittings: All-State 430 with Duzall Flux, Engelhard Silvabrite with Engelhard General Purpose Flux or J.W. Harris Co.
2. Valves, Cast Fittings or Bronze Fittings: Harris Stay-Silv-15 or Handy & Harmon Sil-Fos.
3. Applied locations: Above grade piping 2-inch and smaller for the following services: Heating water.

C. Valves, Cast Fittings or Bronze Fittings: Harris Stay-Silv-15 or Handy & Harmon Sil-Fos.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Install unions in all non-flanged piping connections to apparatus and adjacent to all screwed control valves, traps, and appurtenances requiring removal for servicing so located that piping may be disconnected without disturbing the general system.

B. Install all piping as to vent and drain. Install according to manufacturer's recommendations.

C. Support all piping independently at apparatus so that its weight shall not be carried by the equipment.

D. Run piping clear of tube cleaning or removal/replacement access area on coils, heat exchangers, chillers, etc.

E. Dielectric Fittings: Provide dielectric couplings, unions, or flanges between dissimilar metals. In addition, provide dielectric couplings as required to isolate cathodically protected piping and equipment.

3.2 PIPING JOINTS

A. Pipe and fittings shall be joined using methods and materials recommended by manufacturer in conformance with standard practice and applicable codes. Cleaning, cutting, reaming, grooving, etc. shall be done with proper tools and equipment. Hacksaw pipe cutting prohibited. Peening of welds to stop leaks not permitted.

B. Purge refrigerant piping with nitrogen continuously during the piping installation, and seal each branch outlet with Visqueen and tape or similar method to assure continued cleanliness of interior of piping until system is completed.

C. Copper Piping: Pipe cut evenly with cutter, ream to full inside diameter; end of pipe and inside of fitting thoroughly cleaned and polished. Joint shall be uniformly heated, and capillary space completely filled with solder or braze material, leaving full bead around entire circumference.

D. No couplings installed in floor or wall sleeves.

E. PVC Piping: Socket weld joints with solvent cement and application method recommended by manufacturer. Use power saw and miter box to cut PVC pipe, except DI piping must be cut with a wheel cutter specifically made for plastics. Allow proper curing time based on temperature range during cure period before pressure testing.

3.3 ADJUSTING AND CLEANING

A. General:

1. Clean interior of all piping before installation.
2. Flush sediment out of all piping systems after installation before connecting mechanical equipment to the piping.
3. When placing the water systems in service during construction, each system shall be cleaned by circulating a solution with 1000 ppm of trisodium phosphate for 24 hours, then drained, flushed and placed in service.
4. Clean all strainers prior to placing in service.

END OF SECTION 232113

SECTION 233101 - HVAC DUCTS AND CASING-LOW PRESSURE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The provisions of Section 230500, Common Work Results for HVAC apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes: Low pressure ductwork and fittings.

B. Related Sections include:

1. Section 230548 Vibration and Seismic Controls for HVAC Piping Equipment.
2. Section 230700 Insulation for HVAC.
3. Section 233300 Air Duct Accessories.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: Work performed by qualified, experienced mechanics, in accordance with the manual of Duct and Sheet Metal Construction of the Sheet Metal and Air Conditioning Contractors National Association and these Specifications.

B. Regulatory Requirements:

1. Entire ductwork system, including materials and installation, installed in accordance with NFPA 90A.
2. Ductwork and components shall be listed as U.L. 181, Class I air duct, flame rating not to exceed 25 and smoke rating not to exceed 50.

1.4 SUBMITTALS

A. Submit the following:

1. Provide catalog data on each product specified hereunder.
2. Schedule of duct construction standards.
3. Provide shop drawings showing construction details, support and seismic restraint of ductwork distribution systems.

PART 2 - PRODUCTS

2.1 SUPPORTS, ANCHORAGE AND RESTRAINTS

A. General:

1. When supports, anchorages, and seismic restraints for equipment, and supports and seismic restraints for ductwork are not shown on the Drawings, the contractor shall be responsible for their design.
2. Seismic restraints and anchorages shall resist seismic forces as specified in the latest edition of the International Building Code for the seismic zone in which the project is constructed.
3. Seismic restraints shall follow the provisions described in Section 230548, Vibration and Seismic Control for HVAC Piping and Equipment.
4. Seismic restraints shall not introduce stresses in the ductwork caused by thermal expansion or contraction.
5. Connections to structural framing shall not introduce twisting, torsion, or lateral bending in the framing members. Provide supplementary steel as required.

B. Suspended Ductwork: Seismic restraints shall be in accordance with the latest edition of the SMACNA “Seismic Restraint Manual - Guidelines for Mechanical Systems” for the seismic hazard level corresponding to the seismic zone in which the project is constructed.

C. Engineered Support Systems: The following support systems shall be designed, detailed, and bear the seal of a professional engineer registered in the State having jurisdiction:

1. Supports and seismic restraints for suspended ductwork and equipment.
2. Support frames for ductwork and equipment which provide support from below.
3. Equipment and ductwork support frame anchorage to supporting slab or structure.

2.2 SHEETMETAL DUCTWORK

A. Fabricate from galvanized steel, unless noted otherwise.

B. Minimum gauge, duct construction, joint reinforcing, fittings, hangers and supports shall be in accordance with SMACNA “HVAC Duct Construction Standards – Metal and Flexible”, Latest Edition.

C. Duct Classification: Ducts shall be considered low pressure when design velocities are 2000 fpm or less and maximum static pressure is 2 inches W.G. positive or negative.

1. The following ductwork constructed in accordance with minimum reinforcement requirements for static pressure class of 1/2-inch W.G. positive or negative.

    a. Supply ductwork downstream from terminal units.
    b. Supply, return or exhaust ductwork serving fans scheduled to operate at less than 1/2-inch W.G.
    c. Supply, return, or exhaust branch ductwork which serves one or two inlets/outlets.

2. The following ductwork constructed in accordance with minimum reinforcement requirements for static pressure class of 1-inch W.G. positive or negative.

    a. Supply, return, or exhaust ductwork serving fans scheduled to operate at less than 1 inch W.G. On supply fans pressure drops for louvers, coils, clean filters, and sound traps may be deleted from scheduled fan static.
    b. Supply, return, or exhaust ductwork serving multiple duct branches where contractor can demonstrate that pressures will not exceed 1 inch W.G. positive or negative.

3. The following ductwork constructed in accordance with minimum reinforcement requirements for static pressure class of 2 inches W.G., positive or negative.

    a. Supply, return, or exhaust ductwork serving fans scheduled to operate at pressures greater than 1 inch W.G. positive or negative.

D. Longitudinal seams on rectangular duct shall be Pittsburgh or Button punch snap lock. Snap lock seams for round duct may be used only on ducts classified for 1/2 inch W.G. Longitudinal seams for round ducts using lap and rivet, spot weld, or fillet weld may be used only on ducts classified for statics 1 inch W.G. or less.

E. Joining and reinforcing systems manufactured by Ductmate, Roloc, or TDC are acceptable. Ductmate 35 is equivalent to SMACNA “J”, and Ductmate 25 is equivalent to SMACNA “F”.

F. Use of adjustable round elbows not permitted.

2.3 FLEXIBLE DUCTS

A. Acceptable Manufacturers:

1. Thermaflex M-KE, Gen Flex IMP-25S.
2. Other Manufacturers: Submit Substitution Request.

B. Description: Flexible air duct with CPE or metal film liner permanently bonded to coated spring steel wire helix with 1-inch thick fiberglass insulation blanket covered with fiberglass reinforced metal film vapor barrier jacket. Duct rated for 6-inch W.G. positive and 1-inch W.G. negative.

PART 3 - EXECUTION

3.1 APPLIED LOCATIONS

A. Supply ductwork on downstream side of terminal box. Galvanized sheet metal ductwork, lined where indicated on the Drawings or as specified in Section 230700.

B. Supply Ductwork from Spin-In Fittings to Supply Outlet Collar Connection: Flexible duct, maximum 4'-0" length.

C. Return Air Trunk Ductwork from End Run to Unit Connection: Galvanized sheet metal ductwork, lined where indicated on the Drawings or as specified in Section 230700.

D. Exhaust Ductwork: Galvanized sheet metal ductwork, lined where indicated on the Drawings or as specified in Section 230700.

E. Ductwork between Transfer Grilles: Galvanized sheet metal ductwork, lined where indicated on the Drawings or as specified in Section 230700.

3.2 INSTALLATION

A. Ductwork:

1. Seal traverse joints with an approved mastic during joining procedure or tape after joining to provide airtight duct system.
2. Low pressure ductwork hanger and support systems in accordance with SMACNA "HVAC Duct Construction Standards – Metal and Flexible". Wire supports are not allowed.
3. Fabricate changes in direction to permit easy air flow, using full 1.5D radius bends or fixed turning vanes in square elbows. Radius elbows less than 1.5D radius shall have splitter vanes.
4. Change in duct size or shape necessitated by interference made using rectangular equivalents of equal velocity.
5. Where pipe, structural member, or other obstruction passes through a duct, provide streamlined sheet metal collar around member and increase duct size to maintain net free area. Fit collar and caulk to make air tight.

B. Sound Attenuation (Internal Insulation):

1. Provide sound attenuation duct where shown and as specified under Section 23 07 00.
2. Duct dimensions shown are net inside attenuating material.

C. Dampers: Install where shown and where necessary to complete final balancing of system. Install regulators as specified in Section 233300 for each specific project condition. Leave all dampers locked wide open in preparation for balancing.

D. Spin-in Fittings:

1. Install at branch takeoffs to outlets using round or flex duct.
2. Connect to flexible duct with draw band strap and minimum of two wraps of duct tape.
3. Leave all dampers locked wide open.

E. Flexible Ducts:

1. Make connections at ends using draw band strap and a minimum of 2 wraps of duct tape.
2. Suspend center spans from structure above using wire as required by code. Connect to manufacturer's eyelet on jacket or use 1-inch wide galvanized steel strap with single loop at top and smooth edges.
3. Suspending duct by laying it on the ceiling is prohibited.
4. Avoid crimping flex duct. All changes in direction shall be made using 2D radius. Duct connections to grilles, registers and diffusers using less than 2D radius bends are not acceptable. Where space is constricted, use sheet metal elbows or Thermaflex Flex Boots (or equal).

3.3 FIELD QUALITY CONTROL

A. Coordination with Balance Agency:

1. Provide services of a sheet metal person familiar with the system ductwork to provide assistance to the balancing agency during the initial phases of air balancing in locating all sheet metal dampers.
2. Install missing dampers required to complete final balancing.

END OF SECTION 233101

SECTION 233102 - HVAC DUCTS AND CASING-MEDIUM PRESSURE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The provisions of Section 230500, Common Work Results for HVAC apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes: Medium pressure ductwork and fittings.

B. Related Sections include:

1. Section 230548 Vibration and Seismic Controls for HVAC Piping and Equipment.
2. Section 230700 Insulation for HVAC.
3. Section 233300 Air Duct Accessories.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: Work performed by qualified, experienced mechanics, in accordance with the manual of Duct and Sheet Metal Construction of the Sheet Metal and Air Conditioning Contractors National Association and these Specifications.

B. Regulatory Requirements:

1. Entire ductwork system including materials and installation, installed in accordance with NFPA 90A.
2. Ductwork and components shall be listed as UL 181 Class I air duct, flame rating not to exceed 25 and smoke rating not to exceed 50.

1.4 SUBMITTALS

A. Submit the following:

1. Shop Drawings of ductwork specified hereunder. Include details of supports and seismic restraint of ductwork distribution systems.
2. Product data on medium pressure round and flat oval ductwork and fittings.
3. Schedule of rectangular duct construction standards.

PART 2 - PRODUCTS

2.1 SUPPORTS, ANCHORAGE AND RESTRAINTS

A. General:

1. When supports, anchorages, and seismic restraints for equipment and supports and seismic restraints for ductwork are not shown on the Drawings, the contractor shall be responsible for their design.
2. Seismic restraints and anchorages shall resist seismic forces as specified in the latest edition of the International Building Code for the seismic zone in which the project is constructed.
3. Seismic restraints and anchorages shall resist seismic forces as specified in the latest edition of the International Building Code for the seismic zone in which the project is constructed.
4. Seismic restraints shall follow the provisions described in Section 23 05 48.
5. Seismic restraints shall not introduce stresses in the ductwork caused by thermal expansion or contraction.
6. Connections to structural framing shall not introduce twisting, torsion, or lateral bending in the framing members. Provide supplementary steel as required.

B. Suspended Ductwork: Seismic restraints shall be in accordance with the latest edition of the SMACNA “Seismic Restraint Manual - Guidelines for Mechanical Systems” for the seismic hazard level corresponding to the seismic zone in which the project is constructed.

C. Engineered Support Systems: The following support systems shall be designed, detailed, and bear the seal of a professional engineer registered in the State having jurisdiction:

1. Supports and seismic restraints for suspended ductwork and equipment.
2. Support frames for ductwork and equipment which provide support from below.
3. Equipment and ductwork support frame anchorage to supporting slab or structure.

2.2 GENERAL

A. Fabricate from galvanized steel unless otherwise noted.

B. Minimum gauge, duct construction, joint reinforcing, fittings, hangers, and supports in accordance with the latest edition of SMACNA “HVAC Duct Construction Standards”, Third Edition, 2005.

C. Duct Classification: Ducts shall be considered medium pressure when design velocities exceed 2000 fpm or static pressure is 2.0-inches WG or greater positive. Ducts constructed in accordance with minimum reinforcement requirements for static pressure class of 3 inches.

2.3 SINGLE WALL ROUND DUCT AND FITTINGS

A. Materials:

1. Medium pressure round ductwork up to 36-inch diameter spiral lock seam. Round ducts over 36 inches in diameter either spiral lock seam or shop fabricated with longitudinal seams.
2. Takeoffs: Main and branch takeoffs similar to United Spiral Uniform Duct fittings type SRHTC, SRHTL, or SRHL, typically. No saddle fittings allowed. All fittings welded. Saddle fittings with pop rivet fasteners and sealed with high pressure duct sealer may be used only when adding takeoff fittings to existing duct.
3. Transitions, Elbows:

    1. Transitions of concentric type or eccentric type to maintain elevations detailed, with not more than 15 degree angle variation on sloped portion.
    2. 90 degree elbows of 5 piece design with centerline radius equal to 1-1/2 of duct diameter minimum. Mitered elbows not allowed.
    3. 60 degree and 45 degree elbows of 3 piece design with long radius.
    4. Y-Branch fittings similar to United Uniseal SRHY or SRHYR. Bull head tees not allowed.

2.4 RECTANGULAR STEEL DUCTWORK

A. Fabricate from galvanized steel unless noted otherwise.

B. Longitudinal seams shall be Pittsburg type. Button punch snap lock may be used only if sheetmetal screws are added on 24-inch centers.

C. Joining and reinforcement systems as manufactured by Ductmate, Roloc, or TDC are acceptable. Ductmate 35 is equivalent to SMACNA “J” reinforcement and Ductwork 25 is equivalent to SMACNA “F”. Fasten ductmate to duct with sheetmetal screws minimum of 6-inch on center.

D. Fittings:

1. Fabricate fittings for easiest airflow using radius elbows with center-line radius elbows equal to 1-1/2 times the duct dimension in the plane of the turn.
2. Transitions: Concentric or eccentric type to maintain elevations with not more than 15 degree angle variation on sloped portion.
3. Conical Taps: For branch take-off to terminal unit, construct with inlet 4 inches wider than outlet and no raw edges inside.

E. Use of mitered elbows without turning vanes is not acceptable except where indicated on drawings. Radius elbows with centerline radius less than 1.5D radius shall be vaned type and may be used only with approval of engineer.

PART 3 - EXECUTION

3.1 APPLIED LOCATIONS

A. Supply ductwork serving fans scheduled to operate at pressures greater than 2 inches W.G. positive.

3.2 MEDIUM PRESSURE ROUND DUCTWORK INSTALLATION

A. Install in accordance with manufacturer's instructions and with the latest edition of SMACNA "HVAC Duct Construction Standards".

B. Seal all traverse and longitudinal joints with high pressure duct sealer and wrap with duct sealer tape or hard cast with minimum 2-inch overlap.

C. Field connections for ducts 36-inch diameter and less for round duct and 42 inches major axis and less for oval ducts not requiring additional reinforcing shall use slip on connections. Other ducts shall use flanged joint connections, fabricated and sealed per manufacturer's instructions.

D. Oval duct shall use reinforced per SMACNA standards.

E. Branch takeoffs rigidly connected to terminal unit without flex duct.

3.3 MEDIUM PRESSURE RECTANGULAR DUCT INSTALLATION

A. Install duct, fittings, supports, and hangers in accordance with the latest edition of SMACNA "HVAC Duct Construction Standards".

B. Seal traverse and longitudinal joints with high pressure duct sealer and wrap with duct sealer tape or hard cast with minimum 2-inch overlap.

C. Provide supplementary steel for support of ductwork in shafts and between building structural members.

D. Change in duct size or shape necessitated by interference shall be made using rectangular equivalents of equal velocity.

3.4 FIELD QUALITY CONTROL

A. Field Tests: Perform leakage tests in accord with Section 230590.

END OF SECTION 233102

SECTION 233300 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The provisions of Section 230500, Common Work Results for HVAC apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes: Medium and low pressure duct accessories, sealants and tapes.

B. Related Sections include:

1. Section 233101 HVAC Ducts and Casing-Low Pressure.
2. Section 233102 HVAC Ducts and Casing-Medium Pressure.
3. Section 230900 Instrumentation and Controls for HVAC.

1.3 QUALITY ASSURANCE

A. Work performed by qualified, experienced mechanics in accordance with the manual of Duct and Sheet Metal Construction of the National Association of Sheet Metal and Air Conditioning Contractors and these Specifications.

B. Install entire ductwork system, including materials and installation, in accordance with NFPA 90A.

C. Tapes and sealants listed as UL 181, Class I air duct. Flame spread rating not to exceed 25 and smoke developed rating not to exceed 50.

PART 2 - PRODUCTS

2.1 MEDIUM PRESSURE DUCT ACCESSORIES

A. Acceptable Manufacturers:

1. As indicated.
2. Other Manufacturers: Submit Substitution Request.

B. Duct Sealer:

1. Based On: McGill Airseal Zero.
2. Description: Suitable for indoor/outdoor use, rated to 10-inch WG, Maximum Flame Spread/Smoke Developed Rating of 25/50, maximum VOC of 420 g/L less water. SCAQMD Rule 1168 compliant.

C. Turning Vane Assemblies:

1. Sheet Metal Vanes: Multiple radius hollow vane air foil type with 4-1/2 inch inside radius, galvanized steel construction.
2. Runners: Embossed type.

2.2 LOW PRESSURE DUCT ACCESSORIES

A. Acceptable Manufacturers:

1. As indicated.
2. Other Manufacturers: Submit Substitution Request.

B. Damper Regulators:

1. Ventlok model numbers used, similar products by Young, Durodyne or approved equal are acceptable.
2. Dial Regulator: Concealed or exposed duct in unfinished spaces, blade lengths 18-inch and less, 3/8-inch, Ventlok 635 or 638 for insulated duct. For blade lengths, 19 inches and above, similar except 1/2-inch shafts.
3. Dial Regulator: Exposed duct finished space, 3/8-inch, Ventlok 640.
4. Dial Regulator: Concealed, not accessible, blade lengths 18-inch and less, 3/8-inch Ventlok 666 regulator with 680 mitered gear assembly where right angle turn is necessary. Blade lengths 19 inches and above, similar except 1/2-inch shafts.
5. End Bearings: For ducts rated to 1 inch WG, open end, Ventlok 607. For ducts rated above 1 inch WG, closed end, Ventlok 609. Exposed ductwork, finished spaces, Ventlock 609. Spring end bearings not allowed.

C. Volume Damper Fabrication:

1. Single blade dampers reinforced or crimped for rigidity, with pivot rod extending through duct. Dampers over 12 inches high use multiple opposed blade damper. Single blade damper no larger than 12 inches x 48 inches. Multiple blade damper factory fabricated, Ruskin MD-35 or equal.
2. Minimum gauge and duct construction in accordance with SMACNA “HVAC Duct Construction Standards”, latest edition.
3. Splitter and butterfly dampers fabricated of 18 gauge galvanized steel.
4. Dampers of length suitable to close branch ducts without damper flutter.
5. Damper blade must be aligned with handle and index pointer.

D. Spin-in Fittings:

1. Sheet Metal Duct: Straight pattern sheet metal spin-in fitting with scoops designed for connection to sheet metal ductwork, volume damper, and locking quadrant. Construction with spot welds or rivets. "Button-punch" fabrication prohibited.
2. Fiberglass Duct: Straight pattern sheet metal spin-in fitting with scoops designed for connection to fiberglass ductwork volume damper, and locking quadrant. Construction shall be with spot welds or rivets. "Button-punch" fabrication prohibited.

E. Duct Sealer:

1. Based On: McGill Airseal Zero.
2. Description: Suitable for indoor/outdoor use, rated to 10-inch WG, Maximum Flame Spread/Smoke Developed Rating of 25/50, maximum VOC of 420 g/L less water. SCAQMD Rule 1168 compliant.

F. Duct Tape for Sheet Metal: ARNO C520 duct tape similar United, Duro Dyne, Nashua, Polymer Adhesive.

G. Tape and Adhesive/Activator System for Sheet Metal: Hardcast, Polymer Adhesive.

H. Turning Vane Assemblies:

1. Sheet Metal Vanes: Multiple radius hollow vane air foil type 2-inch (small vane) or 4-1/2-inch (large vane) inside radius, galvanized steel construction.
2. Runners: Push-on type.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install all devices as shown on the Contract Drawings and per manufacturer's recommendations.

B. Medium Pressure Duct Accessory installation specified under Section 233102.

C. Low Pressure Duct Accessory installation specified under Section 233101.

END OF SECTION 233300

SECTION 233600 - AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The provisions of Section 230500, Common Work Results for HVAC apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes: Terminal Units.

1.3 QUALITY ASSURANCE

A. Select units for sound levels, maximum pressure drops, and maximum inlet velocity as specified.

1.4 SUBMITTALS

A. Submit the following:

1. Catalog data, construction details, and performance characteristics for each type and size of terminal unit.
2. Data showing compliance with discharge and radiated sound power level specified.
3. Provide computer calculations for heating coils supplied with unit.
4. Operating and maintenance data.

PART 2 - PRODUCTS

2.1 FAN POWERED TERMINAL UNITS

A. Acceptable Manufacturers:

1. Titus, Nailor, Price, Carnes, Trane, Tuttle and Bailey, Anemostat, Krueger.
2. Other Manufacturers: Submit Substitution Request.

B. Factory assembled packaged complete with VAV section, fan power section arranged for series operation, heating coil, disconnect, controls and internal wiring for a single point field electrical connection. Unit UL, or ETL labeled and listed.

C. Forward curve centrifugal direct drive fan assembly with permanent electrically commutated motors, with infinitely adjustable speed control. Fan and motor assembly completely isolated from the cabinet with rubber vibration mounts to eliminate vibration transmission. Fan motor assembly accessible through access panels from both sides and rear of the cabinet as standard with manufacturer. Gasketed access panels to prevent leakage and vibration transmission. Fan motor shall have thermal overload protection.

D. Fan assembly shall include anti-backward rotation device. A backdraft damper installed in the fan package to prevent reverse air flow when the fan is not operating. The damper constructed of aluminum blades, gasketed to prevent leakage.

E. Volume Regulator Assembly (DDC Controls):

1. Controller and actuator provided by 230900, field mounted in NEMA 1 enclosure.
2. Provide averaging type velocity sensor utilizing multiple sensing points.
3. Air valves all metal construction, non-corrosive, with bearings self-lubricating and moving parts replaceable in the field.
4. Assembled unit tested, factory preset, and guaranteed to provide ±5% total maximum air flow rate through an inlet pressure range to 3.0 inches water.

F. Controls and motor contactor to be enclosed in a NEMA 1 enclosure on the side of the cabinet. Disconnect switch factory mounted and internally wired.

G. Water Heating Coils: See schedule for capacity and Section 238200 for specification.

H. Sound Ratings:

1. Fan Powered Units:

MAXIMUM AIRBORNE SOUND POWER (db)						
	OCTAVE BAND & CENTER FREQUENCY (HZ)					
	2	**3**	**4**	**5**	**6**	**7**
CFM	**125**	**250**	**500**	**1K**	**2K**	**4K**
0 – 900	79	72	68	66	65	63
901 – 1400	85	77	74	71	68	65
1401 – 1800	87	79	74	73	73	71
1801 – 2200	85	79	76	75	73	72

MAXIMUM RADIATED SOUND POWER (db)						
	OCTAVE BAND & CENTER FREQUENCY (HZ)					
	2	3	4	5	6	7
CFM	125	250	500	1K	2K	4K
0 – 1400	79	74	70	60	54	51
*Units must have loaded vinyl wrap over 2-inch thick rigid fiberglass insulation. Refer to Section 230700.						

PART 3 - EXECUTION

3.1 INSTALLATION, TERMINAL UNITS

A. Support terminal units from structure using thread rod and brackets provided. Provide vibration isolation as indicated on plans, and as specified. Make a rigid duct connection to the inlet with minimum length of straight duct upstream of unit as recommended by the manufacturer or as noted whichever is greater.

B. Refer to Section 230700 for duct lining requirements at outlet of terminal units. Maintain 3 feet clear in front of control enclosure.

C. Arrange units for operation with control system. Coordinate with the work specified in Section 230900.

D. Provide a minimum of 5-feet of ductwork prior to first spin-in fitting or outlet branch duct takeoff.

E. Install terminal unit to allow for complete access to controls, and all items requiring maintenance or adjustment. When electrical disconnect is used, coordinate required clearance with NEC requirements, 36-inches minimum. In all other cases maintain a minimum of 30-inches clearance directly in front of the controls.

F. Mount terminal unit controller, actuator to primary air valve, coil connections, control valve, and piping specialties on the same side of the terminal unit.

G. Install filter at return grille prior to operating equipment. Replace filters after substantial completion.

END OF SECTION 233600

SECTION 233700 - AIR OUTLETS AND INLETS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The provisions of Section 230500, Common Work Results for HVAC apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes: Ceiling diffusers and grilles, sidewall grilles.

B. Related Sections include:

1. Section 233300 Duct Accessories.

1.3 SUBMITTALS

A. Submit the following:

1. Shop Drawings: Showing dimensions and details of construction.
2. Product Data.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Where only Titus figure numbers are listed, equivalent products by Carnes, Price, Krueger, Tuttle & Bailey, Anemostat, Nailor are acceptable.

B. All such products shall be of one manufacturer.

C. Other Manufacturers: Submit substitution Request.

2.2 PERFORMANCE

A. Unit sizing is based on air being introduced at 20°F temperature differential and being diffused at the 5-foot level to a velocity not greater than 50 FPM and a temperature differential not greater than 1.5°F. Units are also selected so as not to exceed the NC-30 curve.

2.3 DIFFUSERS AND GRILLES

A. Ceiling Supply Diffuser (C-1): Modular diffuser with adjustable modular core, steel panel, square or rectangular neck size as indicated, discharge pattern as indicated, lay-in tee bar ceiling, or surface mounted as required (coordinate with architectural reflected ceiling plan), white baked enamel finish, Titus MCD.

B. Ceiling Return/Exhaust Grille (C-2): 1/2 x 1/2 x 1/2-inch egg crate grille, neck size as indicated, aluminum construction, baked white enamel finish, face size to match ceiling type. Titus Model 50F.

C. Ceiling Supply Diffuser (C-3): Square ceiling diffuser, adjustable horizontal and vertical discharge pattern, round neck size as indicated, steel construction, baked white enamel finish, Titus TMS.

D. Filter Return Grille (C-4): Aluminum 45° fixed single deflection, horizontal blades, 3/4-inch spacing, 1-1/4-inch border, gasketed around face flange, hinged with frame for 1-inch filter, lay-in tee bar mounted, baked white enamel finish, Titus 3FF.

E. Wall Return/Exhaust Grille (H-2): Steel 35 degree fixed single deflection, horizontal blades, 1/2-inch spacing 1-1/4-inch border, gasketed around face flange, white baked enamel finish, Titus Model 355RL.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install all diffusers tight to their respective mounting surfaces.

B. Installed plumb and true with room dimensions and accurately centered on projections as shown on the Architectural reflected ceiling plans.

C. Install extractors behind all duct mounted sidewall supply grilles, and where shown. Turning vanes allowable if condition is the last outlet on a branch.

D. Set pattern control for directions of throw as shown on Drawings prior to air balancer arriving on Project.

E. Paint ductwork behind all outlets flat black.

END OF SECTION 233700

SECTION 234000 - HVAC AIR CLEANING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The provisions of Section 230500, Common Work Results for HVAC apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes: Air filter assemblies.

1.3 SUBMITTALS

A. Submit the following:

1. Shop Drawings: Details of construction and dimensional data.
2. Product Data: Air filters, gauges, including performance data.
3. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 MEDIUM EFFICIENCY PLEATED FILTERS

A. Acceptable Manufacturers:

1. Camfil-Farr 30-30, Cambridge, American Air Filter, Eco-Air Products, Flanders Precisionaire.
2. Other Manufacturers: Submit Substitution Request.

B. Description: 2-inch thick medium efficiency, pleated fabric media disposable type filter with support grid and enclosing frame. U.L. Class 2. Size as indicated on drawings.

C. Rating: 25-30% MERV 7 efficiency rated on ASHRAE Standard 52.1-1992 and 52.2-1999 respectively.

D. Performance: Filters shall be capable of maintaining rated efficiency at 500 fpm face velocity with initial pressure drop not to exceed 0.30" WG and final pressure drop at 0.90" WG.

E. Frame: Provide complete factory assembled galvanized steel frame assembly suitable for filters, including all necessary hardware for supporting and holding filters in place with an air tight seal all around frame, side access on air handling units.

PART 3 - EXECUTION

3.1 INSTALLATION, PLEATED FILTERS

A. Arrange for access and removal of filter elements.

B. Install filters in air handling unit filter racks, filter grilles and other locations shown on the plans.

C. Air handling unit or fans shall not be operated without specified filters properly installed.

3.2 PROTECTION

A. Equipment Operation During Construction:

1. Pleated Filters:

a. If air handlers are operated during construction, replace filters periodically as required to prevent dirt carryover.
b. Install clean filters prior to air balancing.

END OF SECTION 234000

SECTION 238100 - DECENTRALIZED UNITARY HVAC EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The provisions of Section 230500, Common Work Results for HVAC apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes:

1. Wall mounted split system air conditioning units.

B. Related Sections include:

1. Section 230548 Vibration and Seismic Controls for HVAC Piping and Equipment.
2. Section 230900 Instrumentation and Controls for HVAC.
3. Section 230993 Sequence of Operations for HVAC Controls.

1.3 SUBMITTALS

A. Submit the following:

1. Shop drawings showing details of construction, dimensions, arrangement of components, isolation, filters, etc.
2. Product data showing performance data, standard items and accessories, operating weight.
3. Flow diagrams and pipe sizing for refrigerant systems.
4. Operating and maintenance data.
5. Testing Submittals: Provide test plan and test procedures for approval. Explain in detail, step-by-step, actions and expected results to demonstrate compliance with the requirements of this specification and methods for simulating necessary conditions of operation to demonstrate performance of the system. Test plan and test procedures shall demonstrate capability of system to monitor and control equipment and to accomplish control and monitoring specified.

PART 2 - PRODUCTS

2.1 SPLIT-SYSTEM AIR CONDITIONING UNIT

A. Acceptable Manufacturers:

1. Mitsubishi (Mr. Slim), LG, Daikin, Sanyo, Fujitsu.
2. Other Manufacturers: Submit Substitution Request.

B. Indoor Unit:

1. Description: Furnish complete unit including cabinet, wall mounting kit and accessories, refrigerant line set, fan and motor assembly, cooling coil and filter. Unit as scheduled on drawing, factory-tested and assembled, factory wired, refrigerant-to-air heat exchanger, fan/motor assembly, compressor, controls and safety devices, control circuit transformer, shipped in one piece with ARI certification and UL listing.
2. Cabinet: 18 gauge steel, removable panels for access to components. Drain connection and return air filter racks.
3. Furnish integral condensate pump.
4. Fan and Motor: The evaporator fan shall be an assembly with a turbo fan direct driven by a single motor. The fan shall be statically and dynamically balanced and run on a motor with permanently lubricated bearings. The fan shall consist of two (2) speeds, High and Low.
   Controls: Wiring shall run direct from the indoor unit to the controller with no splices. The system shall be capable of automatic restart when power is restored after power interruption

C. Outdoor Unit:

1. Description: Provide air cooled air conditioner (outdoor unit) designed for outdoor installation with factory supplied supports, properly assembled and tested at the factory. Unit shall be completely weatherproofed and include compressor, condenser coils, condensing fans, motor, refrigerant reservoir, charging valve, all controls, and a holding charge of R410A. Provide guards on condenser fans and coil guard.
2. Compressors: Furnish hermetically sealed type with isolation and sound muffling. Units shall have overload and inherent winding thermostat protection to prevent burn out. Provided crankcase heater. Multiple compressors shall be manifolded for single joint connection on liquid and suction lines.
3. Refrigeration Circuits: Unit shall include back seating service valve and gauge ports in liquid and suction lines. Provided refrigerant filter-dryer.
4. Condenser Fans and Motors: Direct driven propeller type fans with permanently lubricated motors.
5. Controls: Provide high and low pressure cutouts, contractors and internal overload protection on all motors. Provide low ambient operation to 20°F outside to maintain condensing temperature on part load operation. Provide short cycle timer.

D. Electrical: Furnish all starters, contactors and disconnects. Arrange for single point electrical connections. Provide power and control wiring.

E. Controls: Provide wall-mounted cooling-only thermostat. Provide retrievable error codes in the event of system abnormality/error. Hand-held remote controller is not acceptable.

PART 3 - EXECUTION

3.1 SPLIT-SYSTEM AIR CONDITIONING UNIT

A. Installation:

1. Install in location shown on the Drawings. Level unit and secure to structure.
2. Make piping connections and unit installation per manufacturer's recommendations and installation guides.
3. Size and run refrigerant piping between fan coil unit(s) and air-cooled condensing unit(s) per manufacturer's recommendations. Provide traps and double suction and/or discharge risers if recommended by the manufacturer.
4. Insulate refrigerant piping as specified in 23 07 00.
5. Pipe condensate to mop sink or nearest floor sink per manufacturers installation guide.
6. Make refrigerant piping connections, install refrigeration accessories and charge system. Provide additional refrigerant as required for proper operation at design capacities.

B. Start-up:

1. General: Comply with manufacturer’s instructions.
2. Install filters before operating unit.
3. Insure proper refrigerant and air flow before operating unit compressor.

C. Provide interconnecting power and control wiring, routed in conduit from the outdoor unit to the indoor unit, and control panel thermostat. Where unit provided requires separate power connections to the indoor and outdoor units, provide at no additional cost. This shall include branch circuit conduit, wiring, circuit breaker, terminations, etc. as required for complete system. Branch circuit serving indoor unit shall originate in same panelboard serving outdoor unit.

END OF SECTION 238100

SECTION 238200 - CONVECTION HEATING AND COOLING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The provisions of Section 230500, Common Work Results for HVAC apply to work specified in this Section.

1.2 SUMMARY

A. This Section includes:

1. Heating Coils, Water.

1.3 SUBMITTALS

A. Submit the following:

1. Catalog data showing dimensions and performance.
2. Computer calculations for coil performance.

PART 2 - PRODUCTS

2.1 HEATING COILS, WATER

A. Terminal Reheating Coils: 0.0045-inch minimum fin thickness; 0.016-inch minimum tube wall thickness; 10 fins per inch maximum. Coils supplied as integral part of terminal unit are acceptable.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Heating Coils: Installed in air supply units as standard with manufacturer or in ductwork as shown.

B. Damaged Coils: Make every effort to prevent damage to both built-up coils and coils of packaged equipment. Comb damaged coil fins to be straight.

END OF SECTION 238200

SECTION 260500 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The provisions of This Section, Common Work Results for Electrical, apply to all sections in Division 26.

C. All Sections of Division 26, ELECTRICAL, are interrelated. When interpreting any direction, material, and method specified in any section of Division 26, consider it within the entirety of Work in Division 26.

1.2 SUMMARY

A. This Section includes Design-Build work.

1. The intent of Division 26 Specifications and Drawings is to provide a complete and workable facility, with complete systems as required by applicable codes, as indicated, and as specified.
2. Include all work specified in Division 26 and indicated on Drawings, including appurtenances, connections, fasteners, and accessories required to make a complete working system, whether indicated or not indicated.
3. See Division 1 Section, “Design-Build”.

B. The Division 26 Specifications and the accompanying Drawings are complementary, and what is called for by one shall be as binding as if called for by both.

1. Items shown on the Drawings are not necessarily included in the Specifications and vice versa.
2. In case of conflict, Specifications supersede Drawings.

C. Imperative language used in Division 26 Sections addresses the Contractor, as specified in Division 1 Section, “Summary”.

1.3 REFERENCES

A. The latest adopted revisions of the publications listed below apply to these Specifications as referenced:

1. International Building Code (IBC).
2. National Electrical Code (NEC).
3. National Fire Protection Association (NFPA).
4. National Electrical Manufacturers Association (NEMA).
5. National Electrical Contractors Association (NECA).
6. American National Standards Institute (ANSI).
7. Institute of Electrical and Electronic Engineers (IEEE).
8. Underwriters Laboratories (UL).
9. Oregon Administrative Rules (OAR).
10. The publications are referred to in the text by acronym or initials in parentheses above.

1.4 SYSTEM DESCRIPTION

A. Ground Systems:

1. Provide complete ground systems indicated.
2. Include conduit system, transformer housings, switchboard frame, and neutral bus, motors, and miscellaneous grounds required by Contract Documents and by applicable codes.

B. System Identification:

1. Clearly identify all elements of the Project electrical system to indicate the loads served, or the function of each item of equipment, connected under this work.
2. Comply with requirements of Division 26 Section, “Identification,” and with applicable codes.

C. Drawings:

1. The Drawings are diagrammatic: they do not show every offset, bend, tee, or elbow which may be required to install work in the space provided and avoid conflicts with other construction.

    a. Prior to installing work, take field dimensions, and note conditions available for, installation.
    b. Follow the Drawings as closely as practical to do so, and install additional bends, offsets, and elbows where required by installation conditions.

        1) Additional offsets, bends, and other connectors are subject to approval by Project Engineer.
        2) Install additional offsets, bends, and other connectors without additional cost to Owner.

c. The right to make any reasonable changes in outlet location prior to roughing in is reserved to the Owner's Representative.

2. Luminaire Designations:

a. Lower case letters adjacent to devices or luminaires indicate switching arrangement or circuit grouping.
b. Numbers adjacent to devices indicate circuit connection.

3. Circuits and Switching:

a. Do not change branch circuiting and switching indicated; nor combine homeruns, without Engineer's prior approval.
b. Do not combine or change feeder runs.

4. Circuit Conductors:

a. Cross or hash marks on conduit runs indicate quantity of No. 12 copper branch circuit conductors, unless otherwise noted.
b. Where such marks do not appear, provide quantity of circuit conductors to the outlets shown to perform the control or circuiting indicated.
c. Include ground, travelers and switchlegs required by the circuiting arrangement indicated.
d. Provide a dedicated neutral conductor with each circuit, do not use a shared neutral conductor between phases unless specifically requested or directed.

1.5 SUBMITTALS

A. Comply with Division 1 Section, "Submittal Procedures".

B. Shop Drawings and Equipment Data:

1. Combine electrical shop drawings and equipment data in Submittal binders.
2. Include in Submittal binders:

a. A complete index of materials and equipment required by Specifications to be documented by submittals.
b. Manufacturer's detailed specifications and data sheets to fully describe equipment furnished.
c. All deviations from the Drawings and Specifications, noted on the submittals. Failure to comply will automatically void any implied approval for use of the equipment on this project.

C. Installation Drawings:

1. Submit prior to starting installation.
2. Show all outlets, devices, terminal cabinets, conduits, wiring, and connections required for the complete system described.

D. Record Drawings:

1. Keep record drawings up to date as the work progresses.
2. Show all changes, deviations, addendum items, change orders, corrections, and other variations from the Contract Drawings.
3. Keep record drawings at the jobsite and available for the Architect's review.
4. At the completion of the work, incorporate all deviations from the installation drawings to indicate "as-built" conditions.

E. Operation and Maintenance Data:

1. As specified in Division 1 Section, "Closeout Procedures".
2. Provide a separate manual or chapter for each system as follows:

    a. Low voltage distribution system.
    b. Emergency power system.
    c. Standby power system.
    d. Fire alarm system.
    e. Public address system.
    f. Lighting system.
    g. Lighting control system.
    h. UPS system.

3. Description of system.
4. Operating Sequence and Procedures:

    a. Step-by-step procedure for system start-up, including a pre-start checklist.

        1) Refer to controls and indicators by nomenclature consistent with that used on panels and in control diagrams.

    b. Detailed instruction in proper sequence, for each mode of operation (i.e., day-night, staging of equipment).
    c. Emergency Operation:

        1) If some functions of the equipment can be operated while other functions are disabled, give instructions for operations under those conditions.
        2) Include here only those alternate methods of operations (from normal) which the operator can follow when there is a partial failure or malfunctioning of components or other unusual condition.

    d. Shutdown Procedure:

        1) Include instructions for stopping and securing the equipment after operation.
        2) If a particular sequence is required, give step-by-step instructions in that order.

5. Preventive Maintenance:

    a. Schedule for preventive maintenance.

        1) State the recommended frequency of performance of each preventive maintenance task such as cleaning, inspection, and scheduled overhauls.

    b. Cleaning: Provide instructions and schedules for all routine cleaning and inspection with recommended lubricants.
    c. Inspection: If periodic inspection of equipment is required for operation, cleaning, or other reasons, indicate the items to be inspected and give the inspection criteria.
    d. Provide instructions for lubrication and adjustments required for preventive maintenance routines. Identify test points and given values for each.

6. Manufacturers' Brochures:

    a. Include manufacturers' descriptive literature covering devices and equipment used in the system, together with illustrations, exploded views, and renewal parts lists.
    b. Edit manufacturers' standard brochures so that the information applying to the actual installed equipment is clearly defined.

7. Results of performance testing, as specified in Part 3 of This Section.

F. Submittals Procedures:

1. Review and recommendations by the Architect or Engineer are not to be construed as change authorizations.
2. If discrepancies are discovered between the materials or equipment submitted, and the Contract Documents, either prior to or after the data is processed, the Contract Documents govern.

1.6 QUALITY ASSURANCE

A. Regulatory Requirements:

1. All products and equipments shall comply with Oregon Revised Statute (ORS) 453.005(7)(e) prohibiting pentabrominated, octabrominated and decabrominated diphenyl ethers. Where products or equipments within this specification contain these banned substances, provide complying products and equipments from approved manufacturers with equal performance characteristics.
2. Provide work and materials conforming to:

    a. Local and State codes.
    b. Federal and State laws and regulations.
    c. Other applicable laws and regulations.

3. Obtain and pay for all permits, licenses, and inspection certificates required by authorities having jurisdiction.
4. Pay any other fees required by governing authorities for work of this Division.

B. Install only electrical products listed by a recognized testing laboratory, or approved in writing by the local inspection authority as required by governing codes and ordinances.

1.7 SITE VISITATION

A. The Contractor shall visit the site prior to bidding and become familiar with existing conditions and all other factors which may affect the execution of the work. Coordination of installation of equipment with prior bid packages previously issued shall be completed. Include all related costs in the initial bid proposal.

1.8 COORDINATION

A. Coordinate Work of This Division with all other trades to ensure proper installation of electrical equipment.

1. Review Drawings of other trades or crafts to avoid conflicts with cabinets, counters, equipment, structural members, and other possible impediments to electrical work.
2. Report potential conflicts to Architect prior to rough-in.
3. Proceed with rough-in following Architect's directives to resolve conflicts.
4. In general, the Architectural Drawings govern.

B. Verify the physical dimension of each item of electrical equipment to fit the available space. Contractor's responsibility includes:

1. Coordination of the equipment to fit into the available space.
2. Access routes through the construction.

C. Layout Drawings:

1. Equipment arrangement shown on Drawings is diagrammatic to indicate general equipment sizing and spatial relationship. Contractor shall include, as part of distribution equipment submittal, a scaled floor plan which includes all equipment shown with their submitted sizes. Include all feeder conduit routing, both above-ground and underground, including termination points at equipment. Submit for Engineer's review prior to commencing work.
2. Provide additional wiring details at switchboards, motor control centers, and other areas where work is of sufficient complexity to warrant additional detailing for coordination.
3. Submit layout drawings for approval prior to commencing field installation.

D. Where electrical connections are required for equipment provided as Work of other Divisions, coordinate rough-in and wiring requirements for that equipment with its supplier and installer prior to commencing work. Notify Architect and Engineer of any discrepancies between the actual rough-in and wiring requirements, and those identified on Drawings for resolution prior to installation.

E. Arrange raceways, wiring, and equipment to permit ready access to switches, motors, and control components.

1. Doors and access panels shall be kept clear.

F. Coordinate electrical, telephone, and other utility services with the appropriate serving utility.

1. No additional compensation will be allowed the Contractor for connection fees or additional work or equipment required by the serving utility, but not covered in the Drawings or Specifications.

G. Coordinate underground work with other contractors working on the site.

1. Coordinate particularly with contractors installing storm sewer, sanitary sewer, water, and irrigation lines to avoid conflicts.
2. Common trenches may be used with other trades, providing clearances required by codes and ordinances are maintained.

H. Coordinated Shop Drawings.

1. Shop drawings shall be prepared in two dimensional format.
2. Shop drawings shall include but are not limited to:

1.9 CHANGE ORDERS

A. All supplemental cost proposals by the Contractor shall be accompanied with a complete itemized breakdown of labor and materials. At the Architect's request, Contractor's estimating sheets for the supplemental cost proposals shall be made available to the Architect. Labor shall be separated and allocated for each item of work.

1.10 WARRANTY

A. Provide a written warranty covering the work of this Division as required by the General Conditions.

1. Incandescent lamps are excluded from this warranty.

B. Apparatus:

1. Free of defects of material and workmanship and in accord with the Contract Documents.
2. Built and installed to deliver its full rated capacity at the efficiency for which it was designed.
3. Operate at full capacity without objectionable noise or vibration.

C. Include in Contractor's warranty for Work of Division 26 system damage caused by failures of any system component.

1.11 ALTERNATES

A. Comply with Division 1 Section, "Alternates".

B. Refer to Electrical Drawings for detailed information relating to the appropriate alternates.

PART 2 - PRODUCTS

2.1 GENERAL

A. Where specified materials or methods conflict with applicable codes, the more stringent requirement applies.

B. Provide apparatus built and installed to deliver its full rated capacity at the efficiency for which it was designed.

C. Ensure that entire electrical system operates at full capacity without objectionable noise or vibration.

D. Materials and Equipment:

1. Use materials and equipment that are:

a. New.
b. Of quality meeting or exceeding specified standards.
c. Free of faults and defects.
d. Conforming to Contract Documents.
e. Of size, make, type, and quality specified.
f. Suitable for the installation indicated.
g. Manufactured in accordance with NEMA, ANSI, U.L. or other applicable standards.
h. Otherwise as specified in Division 1 Section, "Product Requirements".

2. Equipment not meeting all requirements will not be acceptable, even though specified by name.

3. Where two or more units of the same class of equipment are furnished, use products of the same manufacturer.

    a. Component parts of the entire system need not be products of same manufacturer.

4. Basis of Design:

    a. Equipment scheduled or specified by performance or model number shall be considered the Basis of Design.
    b. If other equipment is provided in lieu of the Basis of Design equipment, assume responsibility for all changes and costs which may be necessary to accommodate this equipment, including, but not limited to:

        1) Different sizes and locations for connections.
        2) Different dimensions.
        3) Different access requirements.
        4) Any other differences.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. Provide a complete properly operating system for each item of equipment specified.
2. Install materials in a neat and professional manner.
3. Comply with equipment manufacturer's written instructions, the best industry practices, and the Contract Documents.
4. Comply with latest published NECA Standard of Installation, and provide competent supervision.

B. Clarification:

1. Where there is a conflict among manufacturer's instruction, best practice, and the Documents, request clarification from the Architect prior to rough-in.
2. Architect's decision will be final.
3. Work installed without clarification shall be removed and corrected by the Contractor at no cost to the Owner.

C. Existing concrete, block or brick walls are considered not accessible and may require use of Surface Mounted Raceway (SMR) if existing concealed raceway and device boxes are not available for reuse or do not meet the intent of the design (i.e. proximity to egress path, point of use, etc.). Coordinate route and installation where SMR is required with the Architect/Engineer prior to rough-in. The contractor will be responsible for reinstalling SMR routed without such prior approval to the Architects satisfaction.

D. Existing stud walls (wood or metal) with or without blocking with plaster, plasterboard or paneling finish are considered accessible with accessible ceiling, attic, tunnel, or crawl space above, below, or adjacent. Remove, patch, and repair finished surface as required to conceal rough-in for new device locations. If it is determined that a specific instance will not permit concealment of rough-in due to obstructions such as beams, headers, and other structural elements prior approval before rough-in from the Architect is required.

3.2 INSTALLATION IN RATED CONSTRUCTION

A. Install intumescent material around ducts, conduits, and other electrical elements penetrating rated construction.

B. Comply with firestop materials manufacturer's written instructions to prevent spread of smoke or fire through sleeves or block-outs penetrating rated fire barriers.

C. Provide firestop materials specified in Division 7 Section, "Through-Penetration Firestop Systems," and as follows:

1. Capable of passing a 3-hour test per ASTM E-814 (UL 1479).
2. Consisting of material capable of expanding nominally eight times when exposed to temperatures of 250-350°F.
3. An alternate method utilizing intumescent materials in caulk or putty complying with Division 7 Section, "Through-Penetration Firestop Systems" may be used.

3.3 EXCAVATION AND BACKFILL

A. Perform all necessary excavation and backfill for the installation of electrical work in compliance with Division 31.

B. For direct burial cable or non-metallic conduit, a minimum 3-inch cover of sand or clean earth fill shall be placed all around the cable or conduit on a leveled trench bottom. Lay all steel conduit on a smooth level trench bottom, so that contact is made for its entire length. Water shall be removed from trench while electrical conduit is being laid.

C. Place backfill in layers not exceeding 8-inches deep and compact to 95% of maximum density at optimum moisture to preclude settlement.

1. Interior: Bank sand or pea gravel.
2. Exterior: Excavated material with final 8-inches clean soil.

D. Following backfilling, grade all trenches to the level of surrounding soil. All excess soil shall be disposed of at the site as directed.

E. Provide 6-inches wide vinyl tape marked "ELECTRICAL" in backfill, 12-inches below finished grade, above all high voltage cable or conduit runs.

F. Coordinate patching of all asphalt or concrete surfaces disturbed by this work with General Contractor.

3.4 NOISE CONTROL

A. Minimize transmission of noise between occupied spaces.

B. Outlet Boxes:

1. Do not install outlet boxes on opposite sides of partitions back to back.
2. Do not use straight through outlet boxes, except where indicated.

C. Conduit:

1. Route conduit along corridors or other “noncritical” space to minimize penetrations through sound rated walls, or through non-sound-rated partitions between occupied spaces.
2. Grout solid and airtight all penetrations through sound rated partitions.
3. Use flexible connections or attachments between independent wall structures.

    a. Do not rigidly connect (i.e., bridge) independent wall structures.

D. Do not install contactors, transformers, starters, and similar noise-producing devices on walls that are common to occupied spaces, unless otherwise indicated.

1. Where such devices are indicated to be mounted on walls common to occupied spaces, use shock mounts, or otherwise isolate them to prevent the transmission of noise to the occupied spaces.

E. Ballasts, contactors, starters, transformers, and like equipment which are found to be noticeably noisier than other similar equipment on the project will be deemed defective and shall be replaced.

3.5 EQUIPMENT CONNECTIONS

A. General:

1. Provide complete electrical connections for all items of equipment requiring such connections, including incidental wiring, materials, devices, and labor necessary for a finished working installation.
2. Verify the location and method for connecting to each item of equipment prior to roughing-in.
3. Check the amperage, maximum overcurrent protection, voltage, phase and similar attributes of each item of equipment before rough-in and connection.

B. Motor Connections:

1. Make motor connections for the proper direction of rotation.
2. Minimum Size Flex for Mechanical Equipment: 1/2-inch; except at small control devices where 3/8-inch flex may be used.
3. Exposed Motor Wiring: Jacketed metallic flex with minimum 6-inches slack loop.
4. Do not test run pump motors until liquid is in the system.

C. Control devices and wiring relating to the HVAC systems are furnished and installed under Division 23; except for provisions or items indicated in Division 26 Drawings and Specifications.

3.6 EQUIPMENT SUPPORT

A. Minimum Support Capacity:

1. Provide fastening devices and supports for electrical equipment, luminaires, panels, outlets, and cabinets capable of supporting not less than four times the ultimate weight of the object or objects fastened to or suspended from the building structure.

B. Luminaire Supports:

1. Support luminaires from the building structure.
2. Use supports that provide proper alignment and leveling of luminaires.
3. Where permitted at exposed luminaires, install flexible connections neat and straight, without excess slack, and attached to the support device.

C. Support all junction boxes, pull boxes, or other conduit terminating housings located above the suspended ceiling from the floor above, roof, or penthouse floor structure to prevent sagging or swaying.

D. Conduits:

1. Support suspended conduits 1-inch and larger from the overhead structural system with metal ring or trapeze hangers and threaded steel rod having a safety factor of four.
2. Conduits smaller than 1-inch installed in ceiling cavities, may be supported on the mechanical system supports when available space and support capacity has been coordinated with the subcontractor installing the supports.
3. Anchor conduit installed in poured concrete to the steel reinforcing with No. 14 black iron wire.

E. Powder actuated or similar shot-in fastening devices will not be permitted for any electrical work except by special permission from the Architect.

3.7 ACCESS DOORS

A. Location and size of access doors is Work of Division 26.

B. Furnishing and installation of access doors is work of Division 8 Section, "Access Doors and Frames".

3.8 ALIGNMENT

A. Install panels, cabinets, and equipment level and plumb, parallel with structural building lines.

B. Install distribution equipment and all electrical enclosures fitted neatly, without gaps, openings, or distortion.

C. Properly and neatly close all unused openings with approved devices.

D. Fit surface panels, devices, and outlets with neat, appropriate, trims, plates, or covers without overhanging edges, protruding corners, or raw edges.

3.9 CUTTING AND PATCHING

A. General:

1. Comply with Division 1 Section, "Cutting and Patching".
2. Restore to original condition new or existing work cut or damaged by installation, testing, and removal of electrical Work.
3. Patch and finish spaces around conduits passing through floors and walls to match the adjacent construction, including painting or other finishes.
4. Clean up and remove all dirt and debris.

B. Make additional required openings by drilling or cutting. Use of jackhammer is prohibited.

C. Fill holes that are cut oversize so that a tight fit is obtained around the objects passing through.

1. In rated construction, comply with Division 7 Section, "Through-Penetration Firestop Systems".

D. Obtain Architect's permission and direction prior to piercing beams or columns.

E. Where alterations disturb lawns, paving, walks, and other permanent site improvements, repair and refinish surfaces to condition existing prior to commencement of work.

3.10 PROTECTION OF WORK

A. Protect all electrical work and equipment installed under this Division against damage by other trades, weather conditions, or any other causes.

1. Equipment found damaged or in other than new condition will be rejected as defective.

B. Keep switchgear, transformers, panels, luminaires, and all electrical equipment covered or closed to exclude dust, dirt, and splashes of plaster, cement, paint, or other construction material spray.

1. Equipment not free of all such contamination is not acceptable.

C. Provide enclosures and trims in new condition, free of rust, scratches, and other finish defects.

1. If damaged, properly refinish in a manner acceptable to the Architect.

3.11 UNINTERRUPTED SERVICE

A. Maintain electrical service to all functioning portions of the building throughout construction.

B. Pre-arrange with Owner outages necessary for new construction.

1. Comply with Division 1 Section, "Work Restrictions".
2. Apply for scheduled shut-downs minimum 4 weeks prior to time needed and reconfirm a minimum of 72 hours prior to time needed.
3. Contractor is liable for any damages resulting from unscheduled outages or for those not confined to the pre-arranged times. Damages include costs incurred by the Owner and by the Owner's tenants.

C. Maintain signal and communication systems and equipment in operation at all times.

1. Outages of these systems shall be treated the same as electrical power outages.

D. Maintain telephone services in accordance with Division 1 Section, "Temporary Facilities and Controls".

3.12 DEMOLITION AND SALVAGE

A. General:

1. Remove or relocate all electrical wiring, equipment, luminaires, etc., as may be encountered in removed or remodeled areas in the existing construction affected by this work.
2. Disconnect electrical service to hard wired equipment scheduled for removal under other Divisions of Work.

3. Wiring which serves usable existing outlets shall be restored and routed clear of the construction or demolition.
4. Safely cut off and terminate all wiring to be abandoned and remove to leave site clean.

B. Reuse of existing:

1. Existing concealed conduits in good condition may be reused for installation of new wiring where available.
2. Existing undamaged, properly supported surface conduits may be reused where surface conduits are called for, if the installation meets all workmanship requirements of the Specifications.
3. Where new wiring is added or existing wiring disturbed in existing branch circuit raceways, all existing wires shall be replaced with new.

C. Salvage and Disposal:

1. Removed materials, not containing hazardous waste, not scheduled for reuse shall become the property of the Contractor for removal from the site, except for those items specifically indicated on the Demolition Drawings for salvage or reuse.
2. Materials containing, or possibly containing, hazardous waste shall be identified for removal and disposal by the Owner's Hazardous Waste Contractor.
3. Neatly store salvaged items at one location at the site where directed by the Owner's Representative.
4. Salvage properly operating circuit breakers from panels scheduled for removal and use to replace faulty or inadequate breakers in existing panels scheduled to remain.

3.13 WIRING IN PRECAST CONSTRUCTION

A. Coordinate installation of electrical conduit, boxes, fittings, anchors, and miscellaneous items to be concealed in precast concrete assemblies with the General Contractor.

B. Where electrical items are required to be installed in concrete assemblies precast off-site, it will be the Electrical Contractor's responsibility to place the electrical items necessary in the concrete at the off-site locations or pay for the General Contractor to make arrangements for the installation of these items in the precast assemblies. The Electrical Contractor will be held responsible for the proper placement and locations of electrical items at the off-site location.

3.14 COMPLETION AND TESTING

A. General:

1. Comply with Division 1 Section, "Quality Requirements".

B. Upon completion, test systems to show that installed equipment operates as designed and specified, free of faults and unintentional grounds.

1. Schedule system tests so that several occur on the same day.
2. Coordinate testing schedule with construction phasing.
3. Conduct tests in the presence of the Architect or its representative.
4. Notify Architect of tests 48 hours in advance.

C. Engage a journeyman electrician with required tools to conduct equipment tests. Arrange to have the equipment factory representative present for those test where the manufacturer's warranty could be impacted by the absence of a factory representative.

D. Perform tests per the requirements of each of the following systems:

1. Low voltage distribution system.
2. Emergency power system.
3. Standby power system.
4. Fire alarm system.
5. Security system.
6. Public address system.
7. Lighting system.
8. Lighting control system.

E. Provide a written record of performance tests and submit with operation and maintenance data.

3.15 COMMISSIONING

A. Complete all phases of work so the system, equipment, and components can be checked out, started, calibrated, operationally tested, adjusted, balanced, functionally tested, and otherwise commissioned. Complete systems, including all subsystems, so they are fully functional.

B. Perform commissioning as specified in Section 019100, General Commissioning Requirements, the technical sections,

1. Unless specified otherwise in the technical sections, provide factory startup services for the following items of equipment:

a. Transformers.
b. Emergency power systems.
c. Electrical distribution systems.
d. Lighting control systems.

C. Participation in Commissioning:

1. Provide skilled technicians to checkout, startup, calibrate, and test systems, equipment, and components.
2. The Engineer reserves the right to judge the appropriateness and qualifications of the technicians relative to each item of equipment or system.

D. Resolution of Deficiencies:

1. Corrective work shall be completed in a timely fashion to permit timely completion of the commissioning process. Experimentation to render system performance will be permitted.

E. Verification and Documentation:

1. As each test is performed, the Contractor shall have the commissioning manager observe the physical responses of the system and compare them to the specified requirements to verify the test results.
2. Submit site observation reports for deficiencies in the system.
3. Record the result of individual checks or tests on the pre-approved checklist, test, and report form from the commissioning plan and submit results for review.

END OF SECTION 260500

SECTION 260519 - LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The provisions of Division 26 Section, Common Work Results for Electrical apply to this section.

1.2 SUMMARY

A. This Section includes:

1. Copper conductors. Indicated sizes shall be considered minimum for ampacities and voltage drop requirements.
2. Conductors for special systems shall be as recommended by the equipment manufacturer except as noted.
3. Deliver conductors to the job site in cartons, protective covers, or on reels.

B. Related Sections include:

1. Section 260526 Grounding and Bonding for Electrical Systems.
2. Section 260533 Raceways and Boxes for Electrical Systems.
3. Section 260553 Identification for Electrical Systems.

1.3 REFERENCED STANDARDS

A. ASTM: American Society For Testing and Materials:

1. ASTM B 3 – Soft or Annealed Copper Wire.
2. ASTM B 8 – Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
3. ASTM B 33 – Tinned Soft or Annealed Copper Wire for Electrical Purposes.

B. ICEA: Insulated Cable Engineers Association:

1. S-95-658 – Non-shielded 0-2 kV Cables

C. IEEE: Institute of Electrical and Electronic Engineers:

1. IEEE 383 – Type Test of Class IE Electric Cables, Field Splices, and Connections.

D. UL: Underwriters Laboratories:

1. UL 44 – Rubber-Insulated Wires and Cables.
2. UL 83 – Thermoplastic-Insulated Wires and Cables.
3. UL 1277 – Type TC Power and Control Tray Cable.

1.4 SUBMITTALS

A. Submit product data for the following materials:

1. Single conductor 600-volt power and control conductors.
2. Fire pump cable.
3. MC cable.

B. Submittals of the following materials shall consist only of a listing of the manufacturer's name and the applicable catalog numbers of the items to be utilized.

1. Connectors.
2. Branch circuit conductor splices.
3. Splices with compression fitting and heat-shrinkable insulator.

C. Submit cable test data per testing requirements of Part 3.

PART 2 - PRODUCTS

2.1 CONDUCTORS – 600V

A. Type:

1. Copper: No. 12 AWG minimum size unless noted otherwise. No. 12 and No. 10, solid or stranded, No. 8 or larger, Class B concentric or compressed stranded.
2. Aluminum is not permitted and shall not be utilized.

B. Insulation:

1. THHN/THWN-2 for conductors 6 AWG and smaller.
2. XHHW-2 for conductors 4 AWG and larger.

C. Thru wiring in fluorescent luminaires shall be rated for 90 degree C minimum.

D. Manufacturers: General, Essex, Southwire, or equivalent.

2.2 POWER LIMITED WIRING

A. Copper, stranded or solid as recommended by the system manufacturer.

B. Insulation shall be appropriate for the system and location used.

2.3 MC CABLE

A. Sheath: Steel, of the interlocking metal type, continuous and close fitting. The sheath shall not be considered a current carrying or grounding conductor.

B. Conductors: Solid copper, of the same ampacity as the conduit/wire system indicated for the specific location. Provide separate green insulated grounding conductors in circuits where an isolated ground is called for.

2.4 CONNECTORS – 600V AND BELOW

A. Branch Circuit Conductor Splices:

1. Live spring type, Scotchlok, Ideal Wire Nut, Buchanan B-Cap, or 3M Series 560 self-stripping type.

B. Cable Splices: Compression tool applied sleeves, Kearney, Burndy, or equivalent with 600V heat shrink insulation. Except where specifically indicated on the plans, all proposed splice locations shall be submitted for review by the Engineer.

C. Terminator Lugs for Stranded Wire:

1. 10 AWG Wire and Smaller: Spade flared, tool applied.
2. 8 AWG Wire and Larger: Compression tool applied, Burndy, Anderson, or equivalent.
3. Setscrew type terminator lugs furnished as an integral part of switches and circuit breakers will be acceptable.

PART 3 - EXECUTION

3.1 CONDUCTORS

A. Pulling compounds may be used for pulling all conductors. Clean residue from the conductors and raceway entrances after the pull is made.

B. Pulleys or blocks shall be used for alignment of the conductors when pulling. Pulling shall be in accordance with manufacturer’s specifications regarding pulling tensions, bending radii of the cable, and compounds.

C. Make up and insulate wiring promptly after installation of conductors. Wire shall not be pulled in until all bushings are installed and raceways terminations are completed. Wire shall not be pulled into conduit embedded in concrete until after the concrete is poured and forms are stripped.

D. Provide a dedicated neutral conductor with each branch circuit, do not use a shared neutral conductor between phases unless specifically requested or directed.

3.2 MC CABLE

A. MC cable is allowed only where concealed within wall or ceiling cavities.

B. MC cable shall not be used for branch circuit homeruns to branch panelboards. EMT or RMC conduit shall be utilized for all branch circuit homeruns to branch panelboards.

3.3 CONNECTORS

A. Control and special systems wires shall be terminated with a tool applied spade flared lug when terminating at a screw connection.

B. All screw and bolt type connectors shall be made up tight and retightened after an eight hour period.

C. All tool applied compression connectors shall be applied per manufacturer's recommendations and physically checked for tightness.

3.4 COLOR CODING

A. Secondary service, feeders, and branch circuit conductors shall be color coded. Phase color code to be consistent at all feeder terminations, A-B-C left-to-right, A-B-C top-to-bottom, or A-B-C front-to-back. Color code shall be as follows:

120/240 volt 208Y/120 volt	**Phase**
Black	A
Red	B
Blue	C
White	Neutral
Green	Ground*
*Ground for isolated ground receptacles shall be green with yellow tracer.	

B. Use solid color compound or solid color coating for No. 12 and No. 10 branch circuit conductors and neutral sizes.

C. Phase conductors No. 8 and larger color code using one of the following:

1. Solid color compound or solid color coating.
2. Stripes, bands, or hash marks of color specified above.
3. Colored as specified using 3/4-inch wide tape. Apply tape in half overlapping turns for a minimum of three inches for terminal points and in junction boxes, pull boxes, troughs, manholes, and handholes. Apply the last two laps of tape with no tension to prevent possible unwinding. Where cable markings are covered by tape, apply tags to cable stating size and insulation type.

D. Switchlegs, travelers, etc., to be consistent with the phases to which connected or a color distinctive from that listed.

E. Color-coding of the flexible wiring system conductors and connectors shall be the manufacturer's standard.

F. For modifications and additions to existing wiring systems, color-coding shall conform to the existing wiring system.

3.5 FIELD TESTING

A. All 600-volt rated conductors shall be tested by the Contractor for continuity. Conductors 100A and over in size shall be meggered after installation and prior to termination. Provide the megger, rated 1,000 volts d.c., and record and maintain the results, in tabular form, clearly identifying each conductor being tested.

1. Replace cables when test value is less than 15 megohms.
2. Cable test submittal shall include results, equipment used, and date.

END OF SECTION 260519

SECTION 260526 – GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The provisions of Division 26 Section, Common Work Results for Electrical, apply to this section.

1.2 SUMMARY

A. This Section includes:

1. Provide complete ground systems as indicated. Include conduit system, transformer housings, switchboard frame and neutral bus, motors, and miscellaneous grounds required.
2. Provide 600 volt insulated main bonding jumper for utility company connection between ground bus in switchgear lineup and ground termination point or service ground in transformer vault as directed by the utility.
3. Provide an insulated ground conductor in every conduit or raceway containing power conductors.
4. Continue existing system as specified herein and shown on the Drawings.

B. Related Sections include:

1. Section 260519 Low Voltage Electrical Power Conductors and Cables.
2. Section 260533 Raceways and Boxes for Electrical Systems.
3. Section 262416 Panelboards.
4. Section 262726 Wiring Devices.
5. Section 262900 Motor Controllers.

PART 2 - PRODUCTS

2.1 GROUND CONDUCTORS

A. Green insulated copper for use in conduits, raceways, and enclosures.

B. Bare copper for ground grids and grounding electrode systems.

2.2 CONNECTORS

A. Cast, set screw or bolted type.

B. Form poured, exothermic welds.

C. Grounding lugs where provided as standard manufacturer's items on equipment.

2.3 GROUND PADS

A. Provide a ground pad at each location shown on the Drawings. Pad shall be 1000A rated copper bus nominally 1/4"x4"x12" long or as shown on the plans.

B. Provide 1/4-inch and 1/2-inch bolt holes per ANSI TIA/EIA 607 standards for telecom ground bars.

C. Mount ground pads with stand-off devices to provide a minimum of 1-1/2 inches free space behind pad for access to lug nuts and washers.

2.4 GROUND RODS

A. Copperclad steel, 5/8"x10'-0" long ground rods. Where ground wells are indicated, provide a 12-inch deep, 8-inch diameter precast concrete well with flush lid for accessibility and inspection of welded connections, RCP Vaults No. 12R12A with 12R12-t cover.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Grounding Conductors: Sized in accordance with Article 250, Tables 250.66 and 250.122 of the National Electrical Code.

B. Grounding Conductor Connectors: Made up tight and located for future servicing and to insure low impedance.

C. Ground the electrical system, the cold-water service, structural steel, and transformers to the building ground grid.

D. All Plug-in Receptacles: Bonded to the boxes, raceways, and grounding conductor.

3.2 UFER GROUND

A. Provide a concrete encased building grounding electrode where shown on the Drawings. Grounding electrode shall consist of a minimum of 20 feet of No. 4/0 bare copper conductor cast into the bottom 6 inches of an exterior concrete foundation or footing.

3.3 EQUIPMENT

A. Provide separate green insulated equipment ground conductor in all non-metallic and flexible electrical raceways. Effectively ground all luminaires, panels, controls, motors, disconnect switches, exterior lighting standards, and noncurrent carrying metallic enclosures. Use bonding jumpers, grounding bushings, lugs, buses, etc., for this purpose.

B. Provide grounding bushings on all feeder conduit entrances to panels and equipment enclosures and bond bushings to enclosures with minimum 10 AWG conductor. Connect the equipment ground to the building system ground. Use the same size equipment ground conductors as phase conductors, up through 10 AWG.

3.4 GROUND PADS

A. Drill ground pads as necessary for attachment of all grounding conductors as required.

B. Utilize 2-hole lugs for terminating 4/0 AWG and larger ground conductors.

C. Bond ground pads to adjacent structural steel with #4/0 bare copper cable, using form poured exothermic welds.

3.5 GROUND RESISTANCE TEST

A. Ground electrode resistance test shall be accomplished with a ground resistance direct-reading single test meter utilizing the Fall-of-Potential method and two reference electrodes. Perform test prior to interconnection to other grounding systems. Orient the concrete-encased ground electrode to be tested and the two reference electrodes in a straight line spaced fifty (50) feet apart. Drive the two reference electrodes five (5) feet deep.

B. Test results shall be in writing and shall show temperature, humidity, and condition of the soil at the time of the tests. In the case where the ground resistance exceeds 5 ohms the Engineer will issue additional instructions.

END OF SECTION 260526

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The provisions of Division 26 Section, Common Work Results for Electrical, apply to this section.

1.2 SUMMARY

A. This section describes supporting devices for electrical equipment, associated conduit, and cable.

B. Related Sections include:

1. Section 260533 Raceways and Boxes for Electrical Systems.
2. Section 260536 Cable Trays for Electrical Systems.
3. Section 262416 Panelboards.
4. Section 265000 Lighting.

1.3 REFERENCED STANDARDS

A. International Building Code (IBC)

B. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)

PART 2 - PRODUCTS

2.1 PRODUCTS

A. Hangers: Kindorf B-905-2A channel, H-119-D washer, C105 strap, minimum 1/2-inch rod with ceiling flange, or equal.

B. Pipe Straps: Two-hole galvanized or malleable iron.

C. Support of Open Cabling: NRTL labeled for support of Category 6 cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.

1. Support brackets with cable tie slots for fastening cable ties to brackets.
2. Lacing bars, spools, J-hooks, and D-rings.
3. Straps and other devices.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide all electrical equipment supports.

B. Install vertical support members for equipment, straight and parallel to building walls.

C. Provide independent supports to structural member for electrical fixtures, materials, or equipment installed in or on ceiling, walls, or in void spaces and/or over furred or suspended ceilings.

D. Do not use other trades' fastening devices to support electrical equipment materials or fixtures.

E. Do not use supports and/or fastening devices to support other than one particular item.

F. Support conduits within 18 inches of outlets, boxes, panels, cabinets, and deflections.

G. Provide complete seismic anchorage and bracing for the vertical and lateral restraint of conduit, cable trays, bus ducts, and electrical equipment as required by IBC Chapter 16 and the most recent version of the SMACNA Seismic Restraint Manual for Seismic Hazard Level (SHL) A. Shop drawings of bracing systems shall be submitted to the Architect for review and shall bear the seal of a professional engineer registered in the State of Oregon.

3.2 LUMINAIRES

A. Light-Duty Ceiling Systems:

1. Attach No. 12 hanger wire from each corner of the luminaire to the structure above.
2. Positively and securely attach luminaire within 6 inches of each corner to the suspended ceiling framing member by mechanical means.

B. Intermediate-Duty Ceiling Systems:

1. Positively and securely attach luminaire within 6 inches of each corner to the suspended ceiling framing member by mechanical means.
2. Attach No. 12 hanger wire within 3 inches of each corner of each luminaire.
3. Connect two 12-gauge slack wires from the luminaire housing to the structure above for luminaires weighing less than 56 pounds.

4. Support luminaries weighing 56 pounds or more directly from the structure above with approved hangers attached to each corner of the luminaire.

C. Heavy-Duty Ceiling Systems:

1. Positively and securely attach luminaire within 6 inches of each corner to the suspended ceiling framing member by mechanical means.
2. Connect two 12-gauge slack wires from the luminaire housing to the structure above for luminaires weighing less than 56 pounds.
3. Support luminaries weighing 56 pounds or more directly from the structure above with approved hangers attached to each corner of the luminaire.

3.3 PULL AND JUNCTION BOXES

A. Pull and junction boxes installed within the cavity of a suspended ceiling that is not a fire rated assembly may be attached to the suspended ceiling framing members, provided the following criteria are met:

1. Installation complies with the ceiling system manufacturer's instructions.
2. Pull or junction box is not larger than 100 cubic inches.
3. The pull or junction box is supported to the main runner with two fastening devices that are designed for framing member application and positively attach or lock to the member.
4. The pull or junction box serves branch circuits and associated equipment in the area.
5. The pull or junction box is within 6 feet of the luminaires supplied.
6. The framing members are not rotated more than 2 degrees after installation.
7. Pull and junction boxes installed within the cavity of a suspended ceiling may be attached to independent support wires, provided the following criteria are met:

    a. Independent support wires are taut and connected at both ends, one end to the ceiling framing member and the other to the structure above.
    b. Pull or junction box is not larger than 100 cubic inches.
    c. The pull or junction box is secured to the independent support wires by two fastening devices that are designed for the application.
    d. Independent support wires in a fire-rated ceiling are distinguishable by color, tagging or other effective means.

3.4 CABLES AND RACEWAY

A. Cables and raceway installed within the cavity of a suspended ceiling may be attached to independent support wires provided the following criteria are met:

1. Independent support wires are taut and connected at both ends, one end to the ceiling framing member and the other to the structure above.
2. Raceways are not larger than one inch trade size and cables and bundled cables are not larger than one inch diameter including insulation.
3. Not more than three raceways or cables are supported by any independent support wire and are supported within the top or bottom 12 inches.

4. Cables for telecommunications, data processing, Class 2 power-limited signaling systems, fiber optics, and other power limited systems are securely fastened within 2 feet of each termination and at intervals not to exceed 5 feet or per the manufacturer's installation instructions.
5. Raceways are secured at intervals required for the type of raceway installed.
6. Cables and raceway are secured to independent support wires by fastening devices and clips designed for the purpose.
7. Independent support wires are distinguishable by color, tagging, or other effective means.

B. Cables and raceway installed within the cavity of a suspended ceiling may be supported with trapezes constructed of steel rods and channels provided the following criteria are met:

1. The size of the rods, channel, and fastening devices are suitable for the anticipated weight.
2. The spacing of the trapezes meets that required for the type of raceway installed.
3. Cables and raceway are secured to a trapeze by straps designed for the purpose.
4. Cables and raceway do not support other raceway or cables.
5. An appropriately sized seismic bracing system is installed.

END OF SECTION 260529

SECTION 260533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The provisions of Division 26 Section, Common Work Results for Electrical, apply to this section.

1.2 SUMMARY

A. This Section includes:

1. Raceways and conduits of specified types for all electrical system wiring, except where clearly indicated otherwise.
2. All fittings, boxes, hangers, and appurtenances required for the conduits and raceways.
3. Size raceways and conduits as indicated. Where no size is indicated, conduit may be the minimum code permitted size for the quantity of conductors installed, based upon NEC tables for conductors with type THW insulation.

B. Related Sections include:

1. Section 260519 Low Voltage Electrical Power Conductors and Cables.
2. Section 260526 Grounding and Bonding for Electrical Systems.
3. Section 260529 Hangers and Supports for Electrical Systems.
4. Section 260553 Identification for Electrical Systems.

PART 2 - PRODUCTS

2.1 METALLIC CONDUITS

A. Rigid Metal Conduit (RMC): Smooth surfaced heavy wall mild steel tube of uniform thickness and temper, reamed and threaded at each end and protected inside and out with galvanizing, sherardizing, or equivalent process. RMC shall comply with NEC Article 344.

B. Intermediate Metallic Conduit (IMC): Smooth surface, intermediate wall mild steel tube of uniform thickness and temper, reamed and threaded at each end, and protected inside and out with galvanizing, sherardizing, or equivalent process. IMC shall comply with NEC Article 342.

C. Electrical Metallic Tubing (EMT): Smooth surface, thin wall mild steel tube of uniform thickness and temper, galvanized or sherardized on the outside, and enameled on the interior. EMT shall comply with NEC Article 358.

D. Flexible Conduits (Flex):

1. Flexible Metallic Conduit: Interlocking single strip steel construction, galvanized inside and out after fabrication. Flex shall comply with NEC Article 348.
2. Liquid Tight: Similar to flexible metallic conduit, except encased in a liquid tight polyvinylchloride or equivalent outer jacket over the flexible steel core, and shall comply with NEC Article 350.

2.2 NON-METALLIC CONDUITS

A. Rigid Non-Metallic Conduit: Type II PVC Schedule 40, suitable for use with 90°C rated wire. Conduit shall conform to UL Standard 65l and carry appropriate UL listing for above and below ground use.

2.3 WIREWAYS

A. Troughs: Steel, painted, square in cross section, preformed knock-outs on standard spacing, screw cover.

B. Fittings: Tees, elbows, couplings as required for configuration shown on the Drawings.

2.4 FITTINGS

A. RMC and IMC:

1. Threaded Locknuts: Sealing type where used with NEMA 2, 3, 3R, 4 and 12 enclosures.
2. Threaded Bushings: 1-1/4-inch and larger, insulated, grounding type as required under Section 260526.
3. Threaded Couplings: Standard threaded of the same material and as furnished with conduit supplied. Erickson type couplings may be used where required to complete conduit runs larger than 1 inch.

B. EMT:

1. Connectors: Steel compression ring or steel set screw type for conduit termination, with insulated throat, suitable for conditions used. Use lay-in grounding type bushings where terminating grounding conductors.
2. Couplings: Steel compression ring or steel set screw type, concrete tight.

C. Threadless: RMC and IMC couplings and box connectors may be steel threadless, compression ring or set screw type for use with conduits 1 inch and smaller where installed in poured concrete locations or where limited working space makes threaded fittings impractical.

D. Weatherproof Connectors: Threaded.

E. Expansion Couplings: Equivalent to O.Z. type EX with jumper.

F. Seal-Offs: With filler fiber, compound, and removable cover.

2.5 METALLIC BOXES

A. Flush and Concealed Outlet Boxes: Galvanized stamped steel with screw ears for device ring mounting, knock-out plugs, mounting holes, fixture studs if required, RACO or equivalent.

B. Surface Outlet Boxes: Galvanized stamped steel same as above for use on ceilings; cast steel or aluminum with threaded hubs or bosses for use on walls.

C. Large Boxes: Boxes exceeding 4-11/16 inches square when required shall be welded steel construction with screw cover and painted, steel gauge as required by physical size, Hoffman, Circle AW or equivalent.

D. Systems: Boxes for systems devices shall be as recommended by the systems manufacturer, suitable for the equipment installed. Equip with grounding lugs, brackets, device rings, etc., as required.

2.6 FLOOR BOXES

A. Combination concealed power, data and communications services floor box with flush hinged door and cover assembly. Nominal 12” x 6”x 3” stamped steel concrete tight box with multiple conduit entrances and pre-pour and after-pour adjusting screws.

1. Heavy gauge steel door plate suitable for carpet cut-in.
2. Gray. High impact thermoplastic trim and carpet flange.
3. Tilted steel service plates for power and signal devices.
4. Hubbell 3SFB-SS series or equal.

2.7 NON-METALLIC BOXES

A. PVC, molded enclosures, threaded hubs.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Conceal all conduits in finished spaces. Concealed conduits shall run in a direct line with long sweep bends and offsets. RMC and IMC embedded in concrete below grade or in damp locations shall be made watertight by painting the entire male thread with Rustoleum metal primer or equivalent before assembly.

B. Route exposed conduit parallel or at right angles to structural building lines and neatly offset into boxes. Conduits attached directly to building surfaces shall closely follow the surfaces. Conduit fittings shall be used to "saddle" under beams. Drilling or notching of existing beams, trusses on structural members shall be coordinated with Architect prior to commencing.

C. RMC and IMC terminations at boxes, cabinets, and general wiring enclosures shall be rigidly secured with double locknuts and bushings or approved fittings. Conduit shall be screwed in and shall engage at least five threads in hub where conduit boxes with threaded hubs or bosses are used. Insulating bushings shall be used for conduits 1-1/4-inches or larger.

D. Keep conduit and raceways closed with suitable plugs or caps during construction to prevent entrance of dirt, moisture, concrete, or foreign objects. Raceways shall be clean and dry before installation of wire and at the time of acceptance.

E. Pack spaces around conduits with polyethylene backing rods and seal with polyurethane caulking to prevent entrance of moisture where conduits are installed in sleeves or block-outs penetrating moisture barriers.

3.2 CONDUIT

A. RMC:

1. RMC may be used in all areas for all wiring systems.
2. RMC shall be installed for all exposed runs of medium voltage circuits outside of the electrical rooms.
3. RMC shall be installed where subject to mechanical injury.
4. RMC shall be installed with threaded fittings made up tight.

B. IMC:

1. IMC may be used for all medium voltage circuits where concealed or where exposed in the electrical rooms.
2. IMC may also be used for all circuits rated 600V and less where not in contact with earth or fill.
3. IMC shall be installed with threaded fittings made up tight.

C. EMT:

1. EMT may be used in all other dry protected locations for circuits rated 600V and less.
2. EMT, whether exposed or concealed, shall be securely supported and fastened at intervals of nominally every 8 feet and within 24 inches of each outlet, ell, fitting, panel, etc.

D. Flex:

1. Flex shall be used for connections to vibration producing equipment and where installation flexibility is required with a minimum 12 inches slack connection.
2. Limit flex length to 36 inches for exposed equipment connections and 72 inches in concealed ceiling and wall cavities.

3. PVC jacketed flex shall be used in wet locations, areas subject to washdown, and exterior locations.

E. PVC:

1. Type II Schedule 40 and 80 PVC may be used underground and in and under interior slabs, poured concrete walls, and where scheduled or noted on the Drawings.
2. Make connections with waterproof solvent cement.
3. Provide RMC at 60 degree and larger bends and where penetrating slabs.

3.3 RACEWAYS

A. Surface metal wireways may be installed at locations to serve motor starters or other control devices where required by a multitude of wiring interconnections or physical layout.

3.4 FITTINGS

A. Metallic raceways and conduits shall be assembled continuous and secured to boxes, panels, etc., with appropriate fittings to maintain electrical continuity. All conduit joints shall be cut square and reamed smooth with all fittings drawn up tight.

B. Crimp-on, tap-on, indenter type, malleable iron or cast set screw fittings shall not be used.

3.5 BOXES

A. General:

1. Outlet boxes shall be of code required size to accommodate all wires, fittings, and devices.
2. Provide multi-gang boxes as required to accept devices installed with no more than one device per gang.
3. Equip all metallic boxes with grounding provisions.

B. Size and Type:

1. Flush wall switch and receptacle outlets used with conduit systems shall be 4 inches square, 1-1/2 inches or more deep, with one or two-gang plaster ring, mounted vertically. Where three or more devices are at one location, use one piece multiple gang tile box or gang box with suitable device ring.
2. Wall bracket and ceiling surface mounted luminaire outlets shall be 4-inch octagon 1-1/2 inches deep with 3/8-inch fixture stud where required. Wall bracket outlets shall have single gang opening where required to accommodate luminaire canopy. Provide larger boxes or extension rings where quantity of wires installed requires more cubic capacity.
3. Junction boxes installed in accessible ceiling or wall cavities or exposed in utility areas shall be a minimum of 4 inches square, 1-1/2 inches deep with appropriately marked blank cover.

4. Boxes for the special systems shall be suitable for the equipment installed. Coordinate size and type with the system supplier.

C. Pull Boxes

1. Provide pull boxes where shown for installation of cable supports or where required to limit the number of bends in any conduit to not more than three 90-degree bends.
2. Use galvanized boxes of code-required size with removable covers installed so that covers will be accessible after work is completed.

D. Installation:

1. Boxes and outlets shall be mounted at nominal centerline heights shown on the drawings.
2. Adjust heights in concrete masonry unit (CMU) walls to prevent devices or finish plates from spanning masonry joints.
3. Recessed boxes shall be flush with finished surfaces or not more than 1/8-inch back and be level and plumb. Long screws with spacers or shims for mounting devices will not be acceptable. No combustible material shall be exposed to wiring at outlets.
4. Covers for flush mounted boxes in finished spaces shall extend a minimum of 1/4-inch beyond the box edge to provide a finished appearance. Finish edge of cover to match cover face.
5. Boxes installed attached to a stud in sheet rock walls shall be equipped with opposite side box supports equivalent to Caddy #760. Install drywall screw prior to finish taping. Methods used to attach boxes to studs shall not cause projections on the face of the stud to prevent full-length contact of sheet rock to the stud face.

3.6 PULL WIRES

A. Install nylon pull lines in all empty conduits larger than 1 inch where routing includes 25 feet or more in length or includes 180 degrees or more in bends.

B. Where conduits requiring pull lines are stubbed out and capped, coil a minimum of 36 inches of pull line and tape at termination of conduit for easy future access. Label pull lines as to conduit starting or terminations point and intended future use.

END OF SECTION 260533

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The provisions of Division 26 Section Common Work Results for Electrical, apply to this section.

1.2 SUMMARY

A. This Section includes: Clearly and properly identify the complete electrical system to indicate the loads served or the function of each item of equipment connected under this scope of work.

B. Related Sections include:

1. Section 260519 Low Voltage Electrical Power Conductors and Cables.
2. Section 260533 Raceways and Boxes for Electrical Systems.
3. Section 260943 Network Lighting Controls.
4. Section 262416 Panelboards.
5. Section 262726 Wiring Devices.
6. Section 262900 Motor Controllers.
7. Section 265000 Lighting.
8. Section 283000 Fire Detection and Alarm.

PART 2 - PRODUCTS

2.1 LABELS

A. Pre-printed: Permanent material pre-printed with black on white, with adhesive backing, Brady, 3M or equivalent.

B. Engraved Laminated Plastic: 3-ply laminated plastic, colors indicated herein, with beveled edges, engraved letters and stainless steel screw attachment. Nameplate length to suit engraving. Adhesive attachment is not acceptable.

C. Clear Plastic Tape: Black (normal) or red (emergency or standby) 12 point Helvetica medium text, clear adhesive backing, field printed with proper equipment for device labeling. Brother P-Touch, Dyno-tape, Kroy, or equal.

D. Wire Markers: White with black numbers, adhesive backed tape on dispenser roll, Brady, 3M or equivalent.

E. Feeder Conduit Marking: Provide one-piece snap-around vinyl feeder conduit markers for feeder conduits. Provide custom label, black letters on orange background indicating destination equipment, 1.25-inch high letters (min) – Seton #M440 Series. Provide additional one-piece snap-around vinyl label, black letters on orange background for voltage designation (i.e. 277/480V, 120/208V). Secure labels to conduits using plastic tie wrap – 2 per label.

F. Marker Pen: Black permanent marker suitable for writing on metallic surfaces.

PART 3 - EXECUTION

3.1 GENERAL

A. Nameplate and text coloring:

1. Normal: Black nameplate with white lettering.
2. Emergency: Orange nameplate with black lettering.
3. Standby: Yellow nameplate with black lettering.
4. UPS: Blue nameplate with white lettering.

3.2 BRANCH CIRCUIT PANELBOARDS

A. Provide engraved laminated plastic nameplate on the face of each panelboard centered above the door as follows:

1. Line 1: Equipment identification (e.g. PANEL 4HA). Text height: 1/2-inch.
2. Line 2: Equipment voltage, phase and wire quantity (e.g. 480Y/277V, 3PH, 4W). Text height: 3/8-inch.

B. Indicate feeder source, feeder wire size, and feeder breaker or fuse size with plastic tape labels on the inside of the panel door.

C. Provide typewritten panel directories, with protective, clear transparent covers, accurately accounting for every breaker installed including spares.

1. Schedules shall use the actual room designations assigned by name or number near completion of the work and not the space designation on the Drawings. Confirm final room designations with Architect and Owner prior to completion of work.
2. Each load description shall include a room or area designation whether indicated on the Drawings or not.

3.3 EQUIPMENT

A. Provide engraved laminated plastic nameplate on the face of all disconnect switches, motor starters, relays, contactors, etc. indicating equipment served (e.g. AHU-1) and equipment load (e.g. 20HP). Provide additional engraved laminated plastic nameplate indicating serving panel designation and circuit number.

B. Provide clear plastic tape label for all relays, contactors, time switches and miscellaneous equipment provided under this Division of work indicating equipment served

3.4 FEEDER CONDUIT

A. Provide feeder conduit marker for all electrical feeders.

B. Markers shall be provided when exiting source equipment and located along the entire conduit length 20ft on centers in exposed areas, above ceilings and upon entering or leaving an area or room.

3.5 DEVICES

A. Label each receptacle plate with preprinted clear plastic tape indicating serving panel and circuit number (e.g. PANEL 2PA-5). Clean all oils, dirt and any foreign materials from plate prior to label application. Receptacles connected to a GFCI protected circuit downstream from the protecting device shall be so labeled.

3.6 RACEWAYS AND BOXES

A. Label all pull boxes and junction boxes for systems with paint or marker pen on box cover identifying system. Where box covers are exposed in finished areas, label inside of cover. Covers shall be color labeled as follows: 480Y/277V wiring - orange; 208Y/120V wiring - black; fire alarm - red; communications - green; security - blue.

B. Label each end of pull wires left in empty conduits with tags or tape indicating location of other end of wire.

3.7 SYSTEMS

A. Complex control circuits may utilize any combination of colors with each conductor identified throughout, using wraparound numbers or letters. Use the number or letters shown where the Drawings or operation and maintenance data indicate wiring identification.

B. Label the fire alarm and communication equipment zones, controls, indicators, etc., with machine printed labels or indicators appropriate for the equipment installed as supplied or recommended by the equipment manufacturer.

3.8 EXISTING EQUIPMENT

A. Provide new nameplates and labels for existing distribution equipment in accordance with panel descriptions shown on the Drawings. Provide new labels for feeder devices where labels are non-existent, incorrect or confusing on existing distribution panels affected by this work.

B. Equip existing branch circuit panelboards scheduled to remain with new, accurate, typed, circuit directories where circuiting changes are made.

END OF SECTION 260553

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The provisions of Division 26 Section, Common Work Results for Electrical, apply to this section.

1.2 SUMMARY

A. This Section includes: Wiring devices and plates for all outlet boxes shown.

B. Related Sections include:

1. Section 260519 Low Voltage Electrical Power Conductors and Cables.
2. Section 260526 Grounding and Bonding for Electrical Systems.
3. Section 260533 Raceways and Boxes for Electrical Systems.
4. Section 260553 Identification for Electrical Systems.

1.3 SUBMITTALS

A. Product data.

B. Shop drawings of the occupancy sensor locations shall be prepared by the manufacturer in AutoCAD and submitted for review. The shop drawings shall be coordinated with all other trades and identify actual device locations and quantities within each space required to provide adequate sensing coverage in accordance with manufacturer's recommendations. Identify mounting configuration (i.e. ceiling or wall) and sensor technology proposed at each location.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Wiring devices shall be extra heavy duty grade, with special devices as noted on the Drawings. Should the Drawings indicate a device other than those listed herein, such device shall be of same grade and manufacture as specified below. Furnish a matching plug connector for all special purpose devices that do not have the common 120 volt NEMA 5-20R configuration.

B. All lighting switches and duplex receptacles installed shall have similar appearance characteristics unless noted otherwise.

2.2 WALL SWITCHES

A. Acceptable Manufacturers: Cooper, Hubbell, Leviton, Arrow-Hart, Pass & Seymour.

B. Line Voltage Switches: 20 amp rated, 277 volt, quiet type, extra heavy duty, heavy duty nylon toggle handle, back and side wired with screw terminal connections.

1. As noted on the drawings provide:

a. Pilot light switch: lighted clear toggle.
b. Momentary Contact Switches: 15A, SPDT, center off.
c. Key Switches: 20 ampere, 277V, back and side wired with screw terminal connections.

C. EPO pushbutton switch: Red mushroom head push-off, pull-on with concentric guard, 2-1/4 inch diameter, non-illuminated, heavy duty operator. Provide clear hinged louver to prevent accidental operation. Provide laminated engraved nameplate attached with stainless steel screws indicating “Emergency Power Off” and load served.

D. Dimming Switches: architectural grad, line voltage, 20 amp rated, single pole, slide-to-off type, slide up to brighten and down to dim, decora style, wattage rating and lamp/ballast compatibility as required. Provide 3-way type where shown on plan. Lutron Nova T, Leviton SureSlide, or Hubbell.

E. Except as noted herein, device exposed finish color shall be as follows:

1. Normal power: Gray or as selected by Architect.
2. Emergency power: Red.
3. Standby power: Red.

2.3 RECEPTACLES

A. Acceptable Manufacturers: Hubbell, Leviton, Arrow-Hart, Pass & Seymour.

B. Standard straight blade duplex receptacle: 3-wire, 2-pole with grounding, extra heavy duty, 20 amp rated, NEMA 5-20R configuration, back and side wired with screw terminal connections.

1. Provide hospital grade in patient care areas as required by NEC.
2. Provide tamper-resistant as noted on the drawings or NEC required.
3. Provide isolated ground as noted on the drawings or NEC required.
4. Provide surge suppression receptacles as noted on the drawings.

C. Ground Fault Interrupting straight blade duplex receptacle: heavy duty, 3-wire, 2 pole with grounding, self-testing, green "ON" LED to indicate power, red "ON" LED to indicate ground fault condition, 20 amp rated, NEMA 5-20R configuration, back and side wired with screw terminal connections.

1. Provide hospital grade in patient care areas as required by NEC.
2. Provide tamper-resistant as noted on the drawings or where NEC required.
3. Provide weather-resistant rating at exterior locations as required by NEC.

D. Clock Outlets: As noted on the drawings and compatible with the specified clock system.

E. Special Purpose Receptacles: As noted on Drawings with NEMA configurations.

F. Except as noted herein, device exposed finish color shall be as follows:

1. Normal power: Gray or as selected by Architect.
2. Emergency power: Red.
3. Standby power: Red.
4. UPS: Blue.

2.4 PLATES

A. Acceptable Manufacturers: Hubbell, Leviton, Arrow-Hart, Pass & Seymour.

B. Flush Finish Plates: 0.040" thick, type 302 stainless steel, brush finish.

C. Surface Covers: Galvanized or cadmium plated steel, 1/2" raised industrial type with openings appropriate for device installed.

D. Weatherproof: Extra-Duty while in use covers, UL 514D listed, commercial quality diecast aluminum construction, NEMA 3R rated, gasketed, built-in padlock provisions, built-in cord strain relief provisions, gray powder-coated finish, vertical mounting as required for application or other covers of similar construction for other receptacle configurations.

E. Security Wall Plates: Tamper resistant cold rolled steel or cast aluminum with baked polyester powder enamel finish. Secure with 4 stainless steel Torx head screws.

F. Identification: Identify receptacle plates with a pre-printed label indicating serving panel and branch circuit number. Refer to 26 05 53 Identification for Electrical Systems.

2.5 OCCUPANCY SENSORS

A. Acceptable Manufacturers: Cooper, Watt Stopper, Leviton, SensorSwitch, Hubbell or Lutron. Watt Stopper seriesnumbers are indentified herein to establish the minimum level of quality for each product. Comparable products that meet the requirements of the specification by other acceptable manufacturers identified herein are acceptable.

B. Wall-box Mounted: Passive infrared type, 180 degree coverage, automatic-on operation, 3-wire type, daylight override, adjustable time-out, selectable walk-through mode and override off switch. Single or dual relay type as required or as shown on Drawings. Watt Stopper #PW series.

C. Ceiling Mounted: 360 degree coverage, automatic-on operation, light-level sensing, adjustable time-out, automatic sensing/adjustment for optimal time-out delay setting, selectable walk-through mode, low- or line-voltage as shown on Drawings or described herein, surface mounted, with power pack as required, provide auxiliary contacts.

1. Combination passive infrared and ultrasonic/microphonic type: Watt Stopper #DT-300 series.
2. Passive infrared type: Watt Stopper #CI-300 series.
3. Ultrasonic type: Watt Stopper #UT-300 series.

D. Ceiling/Wall Mounted: 180 degree coverage, automatic-on operation, light-level sensing, adjustable time-out, automatic sensing/adjustment for optimal time-out delay setting, selectable walk-through mode, low-voltage with power pack, surface mounted, provide auxiliary contacts.

1. Combination passive infrared and ultrasonic/microphonic type: Watt stopper #DT-200 series.
2. Passive infrared type: Watt stopper #CX-100 series.

E. Provide all ceiling mounted occupancy sensors with isolated normally open and normally closed output contacts rated at 1A at 30VDC/VAC. Coordinate interface requirements with HVAC contractor.

F. Provide multiple contacts and/or power packs for occupancy sensors that:

1. Control both normal and emergency lighting and require separation of branch circuit wiring systems. In case of occupancy sensor failure, emergency lighting shall fail to the "on" state.
2. Control separate lighting control zones. Unless otherwise noted, occupancy sensors are intended to control all light in a designated zone or room. Contractor is responsible for providing the required power packs to insure functionality of the system.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Devices and finish plates to be installed plumb with building lines. Wall mounted receptacles shall be installed vertically at centerline height shown on the Drawings.

B. Finish plates and devices are not to be installed until final painting is complete. Scratched or splattered finish plates and devices will not be accepted.

C. Switches, receptacles and/or other devices ganged into a common enclosure shall be provided with a separation barrier between devices where the combined circuit voltages within the enclosure exceeds 300 volts.

D. Provide GFCI receptacles as shown on the drawings or as NEC required. Provide a GFCI type duplex receptacle in each required location, do not sub-feed normal receptacles downstream of the GFCI receptacle to obtain the GFCI rating.

E. Provide receptacles with GFCI, tamperproof, weather-resistant or hospital grade ratings as shown on the drawings, appropriate for the installation or required by NEC.

3.2 CORD CAPS

A. All special plugs provided with the receptacles shall be given to the Owner in their cartons with a letter stating the date and the Owner's representative that received the materials.

3.3 COORDINATION

A. The Electrical Drawings indicate the approximate location of all devices. Refer to Architectural elevations, sections and details for exact locations.

B. Coordinate with equipment installer the locations and methods of connection to devices mounted in cabinets, counters, work benches, service pedestals and similar equipment.

3.4 OCCUPANCY SENSORS

A. Line voltage occupancy sensors shall be provided when installed in inaccessible ceiling system, except when auxiliary contacts are required, in which case a low voltage occupancy sensor shall be provided. For installation of low voltage occupancy sensors in inaccessible ceiling systems, coordinate power pack locations with Architect prior to installation and provide access panels as required.

B. Low voltage occupancy sensors shall be provided when installed in accessible ceiling systems.

C. Sensor locations identified on Drawings are diagrammatic and are meant to indicate only that occupancy sensing within a given space is required. Locate sensors to provide maximum coverage of the room, to operate as someone enters the room, and to avoid false operation due to persons outside the room passing an open door.

D. Provide additional sensing heads as necessary or per manufacturer's recommendation to achieve complete coverage of each room.

E. Set sensitivity as required to provide small movement coverage throughout the room without extending coverage beyond the room.

F. System performance testing shall be done with the sensor timing set to the minimum time delay available. Once complete coverage of a given room has been demonstrated, set the delay to 15 minutes.

G. Upon Completion of installation and prior to turning space over to Owner, Contractor shall reset occupancy sensor automatic self-adjustment settings to insure proper time delay self-adjustment for Owner occupant schedule and room use.

H. Allow for up to 24 hours of call-back sensor adjustments to be made by the contractor or occupancy sensor manufacturer qualified installer for up to six months after the owner has taken occupancy of the space.

3.5 TESTING

A. Receptacles shall be tested for line to neutral, line to ground and neutral to ground faults. Correct any defective wiring.

B. Provide testing of patient care receptacles per NFPA 99 6.3.3. Record test results on the "Receptacle Testing and Acceptance Form" and submit to the engineer of record for review and inclusion to the Oregon State Health Department. Receptacles shall be tested per the criteria/requirements of NFPA 99, chapter 6, 3.3

END OF SECTION 262726

SECTION 262900 - MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The provisions of Division 26 Section, Common Work Results for Electrical, apply to this section.

1.2 SUMMARY

A. This Section includes:

1. Provide manual or magnetic motor starters of the proper characteristics for equipment as indicated.
2. Provide motor control centers as indicated.
3. Provide switches of proper characteristics as disconnecting means.

B. Related Sections include:

1. Section 260519 Low Voltage Electrical Power Conductors and Cable.
2. Section 260526 Grounding and Bonding for Electrical Systems.
3. Section 260553 Identification for Electrical Systems.

1.3 SUBMITTALS

A. Shop drawings, including the following information.

1. Field dimensions.
2. Description of materials and finishes.
3. Component connections
4. Anchorage methods.
5. Installation procedures.

B. Product data.

C. Operating and maintenance data.

D. Overload (heater) Sizing: A final listing of all motors and the heater size installed for that motor.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Motor Control Centers, Motor Starters and Visible Blade Disconnects: Same manufacture as the distribution equipment specified in Section 26 24 16, Allen Bradley or approved equivalent.

B. Horsepower Rated Toggle Switches: Arrow Hart, General Electric, Hubbell, Pass & Seymour.

2.2 MOTOR STARTERS

A. Manual starters: NEMA ICS 2, AC general purpose Class A manually operated toggle type full voltage controller for fractional horsepower induction motors, quick-make, quick-break, with thermal overload protection and suitable enclosures.

B. Magnetic starters, Non-reversing: NEMA ICS 2, AC general purpose, full voltage across the line non-reversing type, 120 volt coils, overload relays in each leg, running pilot lights, one normally closed and one normally open auxiliary contacts, 120V control transformers and suitable enclosures. Overload relays shall be an ambient compensated bimetallic type with interchangeable heater pacts. Overload shall be adjustable, have single-phase sensitivity, and manual or automatic reset. Starters shall be suitable for the addition of at least four auxiliary contacts of any arrangement normally open or normally closed. Each starter shall be provided with a NO and a NC auxiliary contacts. The starter shall have a minimum fault interrupting rating of 10,000A.

C. Magnetic Starters, Reversing: NEMA ICS 2, AC general purpose. Reversing starters shall consist of two contactors and a single overload relays assembly. Include electrical interlock and integral adjustable time delay transition between FORWARD and REVERSE rotation. Starters shall be electrically and mechanically interlocked to prohibit line shorts and both starters being energized simultaneously.

D. Magnetic Starters, Two Speed: NEMA ICS 2, AC general purpose. Include electrical interlock and integral adjustable time delay transition between SLOW and FAST speeds. Starters shall be electrically and mechanically interlocked to prohibit both starters being energized simultaneously.

E. Combination Starter/Disconnect, (Circuit Breaker): Combine magnetic motor starter as described above and [motor circuit protector] [thermal magnetic circuit breaker] disconnect in a common enclosure.

1. Motor Circuit Protector: NEMA AB 1, circuit breaker with integral instantaneous magnetic trip in each pole. Circuit protector shall have an externally operated handle, giving positive visual indication of its ON-OFF position.
2. Thermal Magnetic Circuit Breaker: NEMA AB 1, with integral thermal and instantaneous magnetic trip in each pole. Circuit protector shall have an externally operated handle, giving positive visual indication of its ON-OFF position.

F. Combination Starter/Disconnect, Disconnect Switch Type: Combine magnetic motor starter as described above and non-fused or fused disconnect switch in a common enclosure. Switch type shall be as indicated on the drawings. Switch shall have an externally operated handle that shall give positive visual indication of its ON-OFF position.

1. Non-fused Switch Assemblies: NEMA KS 1, enclosed knife switch with enclosed, but visible blades. Switch shall be rated as indicated on the drawings.
2. Fused Switch Assemblies: NEMA KS 1, enclosed knife switch. Fuse clips shall accept Class R fuses. Switch and fuse sizes shall be as indicated on the drawings.

G. Starter Contacts: Totally enclosed, double break, silver-cadmium-oxide power contacts. Contact inspection or replacement shall be possible without disturbing line or load wiring.

H. Overload Relay: NEMA ICS with one-piece thermal unit construction. Thermal units shall be interchangeable. Overload relay control circuit contact shall be replaceable. Thermal units shall be required for starter to operate.

I. Enclosure: ANSI/NEMA ICS 6, Type 1 as indicated, or as required to meet the conditions of installation.

J. Equip starters with H-O-A selector switches, start-stop stations, or other auxiliary control device listed. Where no auxiliary devices are listed, equip each starter with an H-O-A switch.

K. Control circuit transformer shall be provided in each starter. Transformer shall be sized to accommodate the contactor(s) and all control circuit loads. The transformer shall include primary and secondary fuses in all ungrounded conductors.

L. Provide one normally open and one normally closed auxiliary contacts in each starter, unless additional auxiliary contacts are required. Contacts shall be NEMA ICS 2.

M. All starter units shall be provided with control terminal blocks. Terminal blocks shall be rated at 20-Amperes and shall be accessible from inside the unit with the unit door is opened.

N. Push Buttons: Unguarded, recessed type.

O. Indicating Lights: LED type, color to be Green for run, Red for stopped unless otherwise indicated.

2.3 DISCONNECTS

A. Safety and disconnect switches shall be NEMA type HD (heavy duty), quick-make, quick-break, dual rated with electrical characteristics as required by the system voltage and the load served. Switches shall be equipped with a defeatable cover interlock.

B. Enclosures shall be NEMA l for indoor use, unless specifically noted otherwise and NEMA 3R where installed exposed to the weather or designated by the subscript “WP”.

C. Disconnects shall be fusible or non-fusible as designated on Drawings.

2.4 FUSES

A. Fuses shall be UL Class RK-5 dual element, time delay, current limiting type. The overload thermal time delay element shall be a spring actuated soldered copper assembly in a separate sand free compartment. The short circuit current limiting section shall be copper alloy links encased in quartz sand.

B. Fuses shall be capable of holding 500% of rated current for a minimum of 10 seconds, and carry a UL listed minimum interrupting rating of 200,000 amperes rms symmetrical.

PART 3 - EXECUTION

3.1 MOTOR STARTERS

A. Provide the motor starting equipment as shown on the Drawings and coordinate all motor "overload" starter relays.

B. Install the starters at the respective equipment unless shown otherwise.

C. Freestanding starters shall be installed on metal channel support structure.

D. Starters that are installed on exterior walls shall be installed with minimum 1/2-inch channel on wall to allow air space between starter and wall.

E. Where fusible units are provided, install fuses as indicated on the drawings.

F. Thermal overloads (heaters) shall be installed in each starter in accordance with the manufacturer's recommendations for that motor and the type of associated load. Coordinate proper size when individual power factor capacitors are utilized at the motor.

3.2 DISCONNECT SWITCHES

A. Provide all code required disconnect switches under this work, whether specifically shown or not.

B. Non-fusible disconnect switches required when equipment is not in sight of the branch circuit panel or starter may be horsepower rated, toggle type in suitable enclosure, mounted at or on the equipment.

3.3 FUSES

A. Install fuses for motor protection to best protect the motor without nuisance tripping. Should fuse sizes require changing from what is shown due to variance between the original design information and actual equipment installed, fuses shall be sized in accordance with NEC. In no case shall fuses be sized smaller than the starter heaters on motor circuits.

B. Provide one complete set of spare fuses of each amperage used on this project. Store spare fuses in the spare fuse cabinet.

3.4 COORDINATION

A. Verify the characteristics and the motor full load current for each motor installed, using the actual motor nameplate data. Select and install the proper running overload devices in the starter as per the manufacturer's instructions. Provide the proper overload protection is a part of this Division of the work.

B. Prepare table of all motor full load currents and installed overload devices and submit to the Architect.

END OF SECTION 262900

SECTION 265000 - LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The provisions of Division 26 Section, Common Work Results for Electrical, apply to this section.

1.2 SUMMARY

A. General Requirements:

1. Provide all lighting outlets indicated on the Drawings with a luminaire of the type designated and appropriate for the location.
2. Where a luminaire type designation has been omitted and cannot be determined by the Contractor, request a clarification from the Architect in writing and provide a suitable luminaire type as directed.
3. Coordinate installation of luminaires with the ceiling installation and all other trades to provide a total system that is neat and orderly in appearance.
4. Luminaires located in fire rated assemblies shall be rated for use in such assemblies or shall have the assembly maintained by the installer through the use of appropriate construction techniques to maintain the assembly rating. It is the responsibility of the contractor to maintain the assembly rating and provide all required components during construction. Coordinate luminaires impacted with division 1 and life safety documents.
5. Install all remote ballasts in enclosures as required by luminaire specified. Locate remote ballasts as shown on drawings; where no location is shown, provide recommendation for approval prior to commencing field installation. Remote mounted ballasts shall be located within the distance limitations specified by the ballast manufacturer.
6. Coordinate voltage requirements to each luminaire as indicated on drawings.
7. Contractor is responsible for verifying all luminaires carry a valid UL or ELT listing.
8. All luminaires shall be procured through a distributor located within 200 miles of the project site with a valid business license in the state the project is located.
9. Upon request of the architect, engineer or owner, provide all back-up pricing in a unit cost breakdown per luminaire. Back-up pricing shall include distributor net pricing, contractor net pricing, final owner pricing and all mark-ups and discounts (lot price or all-or-none) associated with the luminaires.
10. Lighting related change orders shall include all back-up pricing noted above for review by the engineer and lighting designer.

B. Related Sections include:

1. Section 260519 Low Voltage Electrical Power Conductors and Cables.
2. Section 260526 Grounding and Bonding for Electrical Systems.
3. Section 260923 Lighting Control Devices.
4. Section 260943 Network Lighting Controls.
5. Section 262726 Wiring Devices.

1.3 QUALITY ASSURANCE

A. The lighting design for this project was based on luminaire types and manufacturers as specified.

B. Specified manufacturers are pre-qualified to bid on products where specified. Inclusion of manufacturer and product series does not relieve specified manufacturer from providing product as described in luminaire schedule; modifications to standard product, if required, shall be included with initial bid.

C. Items noted “or equivalent” do not require prior approval but shall be included with the shop drawing submittal.

D. Other “Or Approved” Manufacturers and Products: Submit Substitution Request prior to bid, complying with requirements of “Section 01 25 00 Product Options and Substitutions”. Approval shall be determined by review of the following luminaire characteristics where applicable. Lack of pertinent data on any characteristic shall constitute justification for rejection of the submittal.

1. Performance

a. Distribution.
b. Utilization.
c. Average brightness/maximum brightness.
d. Spacing to mounting height ratio.
e. Visual comfort probability.

2. Construction

a. Engineering.
b. Workmanship.
c. Rigidity.
d. Permanence of materials and finishes.

3. Installation Ease

a. Captive parts and captive hardware.
b. Provision for leveling.
c. Through-wiring ease.

4. Maintenance

    a. Relamping ease.
    b. Ease of replacement of ballast and lamp sockets.

5. Appearance

    a. Architectural integration.
    b. Light tightness.
    c. Neat, trim styling.
    d. Conformance with design intent.

1.4 SUBMITTALS

A. Submit the following in accordance with Section 26 05 00:

1. Shop Drawings, to include:

    a. Product Data. Provide manufacturer's published product data information.
    b. Luminaire dimensions on a fully dimensioned line drawing.
    c. Lamp information.
    d. Lamp socket information.
    e. Ballast information using ballast manufacturers published product data information. Multiple ballasts may be submitted for single luminaire if compatible with ballast specification included in contract documents. Include certification of lamp and ballast compatibility for all submitted ballasts.
    f. Mounting details including clips, canopies, supports, and methods for attachment to structure.
    g. U.L. Labeling information.
    h. Photometric Reports consisting of:

        1) Candlepower distribution curves: Provide five plane candlepower distribution data at no more than 5 degree vertical angle increments.
        2) Coefficient of utilization table.
        3) Zonal lumen summary including overall luminaire efficiency.
        4) Luminaire luminance: Provide measured maximum brightness data for luminaires with reflectors and average brightness data for luminaires with refractors.
        5) Spacing to mounting height ratio. If parallel and perpendicular ratios differ, provide data on each plane.
        6) VCP calculations (where applicable): For general office lighting luminaires, provide typical VCP calculations for ceiling heights between 9' and 12' at 1' increments, for room sizes 20'x20' and 30'x30'.

    i. Special requirements of the specification.

2. Operation and maintenance data. Prepare two copies of a Lighting Systems Maintenance Manual consisting of the following in a hard-cover binder for review. After review, Architect will deliver one copy to Owner.

    a. One complete set of final submittals of actual product installed, including product data and shop drawings. Include product data for actual ballast installed where applicable.
    b. List of lamps used in Project, cross-referenced to fixture types, with specific manufacturer's names and ordering codes.
    c. Relamping instructions for lamps that require special precautions (tungsten halogen, metal halide, etc.).
    d. Lighting fixture cleaning instruction, including chemicals to be used or avoided.

PART 2 - PRODUCTS

2.1 GENERAL

A. Luminaires new and complete with mounting accessories, junction boxes, trims and lamps.

B. Luminaire assemblies U.L. listed.

C. Luminaires U.L. listed appropriate to mounting conditions and application.

D. Each luminaire family type (downlights, parabolics, etc.) supplied by only one manufacturer.

E. Recessed luminaires installed in fire rated ceilings and using a fire rated protective cover shall be thermally protected for this application and shall carry a fire rated listing.

F. Luminaires installed under canopies, roofs or open areas and similar damp or wet locations shall be UL listed and labeled as suitable for damp or wet locations.

2.2 LENSES

A. Prismatic Acrylic:

1. 12"x24" and Larger: Extruded of clear virgin acrylic plastic, 0.125" minimum overall thickness, 0.100" nominal unpenetrated thickness, Pattern 12 with flat sided female prisms running at 45 degrees off panel axis unless otherwise specified in the luminaire schedule. Concave prisms are not acceptable.
2. As specified in the Luminaire Schedule.

B. Opal acrylic:

1. Extruded or injection molded of virgin acrylic plastic, 0.080" minimum overall thickness.
2. As specified in the Luminaire Schedule.

C. Opal acrylic overlay: High transmittance type, extruded of virgin acrylic plastic, 0.040" overall thickness, with minimum 80% light transmittance.

2.3 REFLECTOR CONES

A. Spun of uniform gauge aluminum, free of spinning marks or other defects.

B. Shall have an integral trim flange.

C. Color and finish as specified in Luminaire Schedule.

D. All reflectors shall be of the Alzak® process, and shall be of the low iridescent type.

E. All luminaires using Alzak® reflector cones shall be supplied by the same manufacturer unless directed otherwise in Luminaire Schedule.

2.4 LAMPS

A. Lamp each luminaire with the suitable lamp cataloged for the specific luminaire type and as indicated as manufactured by General Electric, Philips, OSRAM/Sylvania, Venture, Ushio (MR only), EYE (MR only), or approved, or as specifically indicated in the Luminaire Schedule, or as specified herein.

B. Incandescent: Inside frosted, 130 volt rated except where otherwise specified. Reflector (R) flood lamps are not acceptable.

C. Tungsten Halogen Incandescent:

1. Line voltage:

    a. Inside white coated, 120 volt rated except where otherwise specified, BT-15 envelope, medium base. Philips Halogena or approved.
    b. Provide medium base PAR lamps for luminaires designed and cataloged for such lamps unless specified otherwise, 125-130 volt rated. Refer to Luminaire Schedule for size, wattage and beam spread. Lamps with diodes are not acceptable.
    c. Tubular tungsten halogen to be of wattage as listed in Luminaire Schedule and of the proper type for the luminaire.

2. Low Voltage: Of wattage, voltage, beam spread, base style and type indicated in Luminaire Schedule.

D. Fluorescent:

1. Linear Fluorescent:

a. T-8: lamps shall be bi-pin type, Tri-Phosphor with Color Rendering Index (CRI) exceeding 82, Correlated Color Temperature (CCT) to match building standard with a minimum initial lumen output of 2850 lumens when operated on a reference ballast with a ballast factor of 1.0, or as indicated in the Luminaire Schedule.
b. T-5 lamps shall be bi-pin type, Tri-Phosphor with Color Rendering Index (CRI) exceeding 82, Correlated Color Temperature (CCT) of to match building standard as indicated in the Luminaire Schedule.
c. T-12 lamps shall not be used.
d. Provide low mercury (maximum 6 milligrams for standard 48 inch lamp) TCLP-compliant (Toxicity Characteristic Leaching Procedure) lamps for all luminaires.

2. Compact Fluorescent:

a. Of wattage and configuration indicated in Luminaire Schedule, Tri-Phosphor with Color Rendering Index (CRI) exceeding 81, Correlated Color Temperature (CCT) of to match building standard or as indicated in the Luminaire Schedule.
b. Amalgam technology to be used wherever at least one manufacturer supplies the specified lamp with that technology.
c. Lamps shall be single ended four-pin plug-in base where available.
d. Self ballasted lamps shall not be provided unless specifically indicated in the Luminaire Schedule.

3. All fluorescent lamps shall be of the same manufacturer and phosphor coating unless specifically identified in the Luminaire Schedule.

E. Special types as indicated in Luminaire Schedule.

2.5 LAMP SOCKETS

A. Of configuration and design to accept standard lamp bases.

B. Linear Fluorescent:

1. T-8: Polycarbonate medium bi-pin twist lock type, with T12 inhibitor, copper or brass contacts. Straight-in type lampholders are not acceptable.
2. T-5: Polycarbonate medium bi-pin rotary lock type, copper or brass contacts.

C. Compact Fluorescent:

1. Long twin-tube lamps: Polycarbonate plug-in type with metallic lamp retention spring. Listed for both vertical and horizontal mounting orientation. Provide auxiliary lamp support clip.
2. Compact lamps: Polycarbonate plug-in type with metallic lamp retention spring, 4-pin type, starter-free. Twist-lock lamp holders are not acceptable unless specified in the Luminaire Schedule.

2.6 BALLASTS

A. Linear Fluorescent:

1. Non-Dimming Electronic: Ballasts shall meet the requirements of UL 935 and shall bear the appropriate UL label. Tandem wiring between luminaires may be used to minimize the number of ballasts while accomplishing the switching requirements shown on the drawings. Advance, OSRAM/Sylvania, Universal Lighting Technologies, or approved. Ballasts shall have the following electrical characteristics:

    a. Series wired, Programmed Rapid Start circuitry.
    b. High frequency operation, >40kHz.
    c. Withstand input power line transients as defined in ANSI C62.41. The ballasts shall tolerate a line voltage variation of ±10%.
    d. The power factor shall be 98% or higher.
    e. The lamp crest factor shall measure 1.7 or less for program rapid start ballasts and 1.85 or less for instant start ballasts.
    f. The average Ballast Factor shall be a minimum of 84% under ANSI C82.2 conditions or as indicated in the Luminaire Schedule.
    g. Total harmonic distortion of the input current to the electronic ballast shall not exceed 10% of the input current and comply with FCC rules and regulations Part 18 concerning the generation of both EMF (electromagnetic interference) and RFI (radio frequency interference).
    h. Class “A” sound rated and UL Class “P” thermally protected. The ballast shall be provided with an internal fuse to protect the electrical power supply from internal component failure. The ballast shall also be short-circuit protected in the event of miswiring.

2. Non-Dimming Electronic T-8 Super System: Ballasts shall meet the requirements of UL 935 and shall bear the appropriate UL label. Tandem wiring between luminaires may be used to minimize the number of ballasts while accomplishing the switching requirements shown on the drawings. Advance, OSRAM/Sylvania, General Electric, or approved. Ballasts shall have the following electrical characteristics:

    a. Series wired, Programmed Rapid Start circuitry.
    b. High frequency operation, >40kHz.
    c. Withstand input power line transients as defined in ANSI C62.41. The ballasts shall tolerate a line voltage variation of ±10%.
    d. The power factor shall be 98% or higher.

e. The lamp crest factor shall measure 1.7 or less for program rapid start ballasts and 1.85 or less for instant start ballasts.
f. The average Ballast Factor shall not exceed .75 under ANSI C82.2 conditions or as indicated in the Luminaire Schedule.
g. A two lamp ballast, when operating two Super System lamps as specified in the lamp section, shall consume 51 watts maximum with a total system efficacy of not less than 95 lumens per watt.
h. Total harmonic distortion of the input current to the electronic ballast shall not exceed 10% of the input current and comply with FCC rules and regulations Part 18 concerning the generation of both EMF (electromagnetic interference) and RFI (radio frequency interference).
i. Class "A" sound rated and UL Class "P" thermally protected. The ballast shall be provided with an internal fuse to protect the electrical power supply from internal component failure. The ballast shall also be short-circuit protected in the event of miswiring.

3. 10% Dimming Electronic: Ballasts shall meet all the specifications for non-dimming electronic ballasts. Tandem wiring between luminaires shall not be used. Must be compatible with dimmers specified under Section 26 27 26. Ballast shall start lamp at any preset light output setting. Dimming control shall be by 0-10V control circuit with a positive line voltage On/Off. Lutron TVE, OSRAM/Sylvania Pho-Dim, Advance MarkVII or approved to provide continuous, flicker free square law dimming from 100% output to 10% output.
4. Ballasts shall be warranted against defects in materials and workmanship for three years. The warranty shall include either a $10 replacement labor allowance or complete replacement including labor by an agent of the manufacturer.
5. Ballasts shall operate a maximum of two lamps. Three lamp ballasts shall not be provided.

B. Compact Fluorescent:

1. Non-Dimming Electronic: Ballasts shall meet the requirements of UL 935, ANSI C82.11 and shall bear the appropriate UL label. Ballast shall be suitable for lamp type(s) specified. Tandem wiring between luminaires shall not be used. Ballast shall employ integral end-of-life shutdown circuit with auto-reset to remove power from the lamp when the ballast senses lamp failure. Advance, OSRAM/Sylvania, Universal Lighting Technologies, or approved. Ballasts shall have the following electrical characteristics:

a. Series wired, Program Rapid Start circuitry.
b. High frequency operation, >50kHz.
c. The power factor shall be 98% or higher.
d. The lamp crest factor shall measure 1.5 or less.
e. The average Ballast Factor (BF) shall be a minimum of 98%.
f. Total harmonic distortion of the input current to the electronic ballast shall not exceed 10% of the input current and comply with FCC rules and regulations Part 18 concerning the generation of both EMF (electromagnetic interference) and RFI (radio frequency interference).

g. Minimum starting temperature of 0°F ambient. Maximum operating temperature of 120°F ambient.
h. Class "A" sound rated and UL Class "P" thermally protected.

2. 5% Dimming Electronic: Ballasts shall meet all the specifications for non-dimming electronic ballasts. Tandem wiring between luminaires shall not be used. Must be compatible with dimmers specified under section 262726. Dimming control shall be by line voltage control circuit with a positive line voltage On/Off. Lutron Hi-Lume, Lutron Tu-Wire, Advance MarkX, or approved to provide continuous, flicker free dimming from 100% output to 5% output.
3. Magnetic Ballasts: Provide magnetic ballasts only where specifically indicated in Luminaire Schedule or where no electronic version is available. High power factor, rapid start, energy efficient, full light output premium type or special types as required by the luminaires and lamps specified, C.B.M. and UL labeled class "P", Advance or equal. All ballasts shall be fused with in line fuse located behind ballast compartment cover.

C. All dimming ballasts controlled by a common controller shall be provided by the same manufacturer.

D. Ballasts used in enclosed and gasketed luminaires listed for use in wet locations shall be of Type 1 construction.

E. Ballasts shall be rated for the expected ambient temperature in which they are installed. All exterior installed ballasts shall be rated to start the lamps at 0°F.

F. Systems using tandem wired luminaires shall be labeled accordingly. Label shall be in the lamp compartment of each luminaire and identify the function of that luminaire. Label shall not be visible from room.

G. Ballast housing shall have circuit diagrams and lamp connections applied thereto.

H. Remote mounted ballasts shall be not be located beyond the distance limitations specified by the ballast manufacturer.

2.7 FLUORESCENT LUMINAIRES

A. Sheet metal housings: Minimum 22 gauge cold-rolled steel, with welded joints. Exposed weld marks and seams filled and ground smooth.

B. Door Frames for lensed luminaires: White painted, flat aluminum with mitered corners, spring assisted.

C. Finish: Baked white dry polyester powder, unless otherwise specified, with a minimum average reflectance of 85% on all exposed and light reflecting surfaces. Steel components shall be prepared for finishing with a 5-step zinc phosphating process prior to painting. Luminaire (including all painted component parts) shall be painted after fabrication unless specifically noted in the Luminaire Schedule.

2.8 LINEAR FLUORESCENT LUMINAIRES

A. Extruded Aluminum Housing: One piece housing of AA 6063 T5 extruded aluminum with 0.14 minimum thickness smooth and free of tooling lines in one uninterrupted section of 1 foot to 24 foot with the cross sectional dimensions as indicated in the Luminaire Schedule. Section lengths shall be as shown on the drawings and shall be such that the luminaire shall be able to be transported into and out of the installation location after final construction without any building demolition being required.

B. Steel Housing: 20 gauge (0.7mm or 0.027") minimum, free of dents, scratches, or other defects. Exposed weld marks, joints and seams shall be filled and sanded smooth before finishing. All edges shall be cleaned and dressed to remove sharp edges or burrs. Section lengths shall be as shown on the drawings comprised of 1 foot to 12 foot lengths.

C. End Plates: Die cast end plates shall be mechanically attached without exposed fasteners. End caps shall be minimum 0.125" thick.

D. Where housing sections are joined together to form a continuous row, an internal alignment spline shall be provided.

E. Finish:

1. All exposed aluminum surfaces shall be satin etched and clear anodized.

F. Lens: Mechanically secured from within the housing. Lens shall have interior linear prisms with smooth exterior.

G. Louvers and Reflectors:

1. White Reflectors shall be steel or aluminum, minimum 22 gauge, with hard baked white enamel finish with minimum 85% reflectance.
2. Alzak reflectors shall be low iridescent semi-specular or as indicated in the Luminaire Schedule, Alzak® or Coilzak® with minimum reflectance of 90%.

H. Suspension:

1. Suspension Devices, type as specified in the Luminaire Schedule:

   a. Aircraft Cable: Stainless steel type - 3/32" nominal diameter, stranded, with positive pressure, field adjustable clamp at fixture connection.
   b. Rigid Pendant: ½" nominal diameter or as specifically shown on drawings. Supplied by fixture manufacturer when available as standard product. At fixture end of stems, provide earthquake type swivel fitting to permit 45° swing in any direction away from vertical. Flat canopy to permit splice inspection after installation.
   c. Chain hangers: Length to suit fixture mounting height if shown or as field conditions dictate. Use two heavy duty chains with "S" hooks at each suspension point. Length to suit mounting height as shown on Drawings.

d. Suspension system must permit ±13mm (1/2") minimum vertical adjustment after installation.

2. Supports:

a. Provide internal safety cable from fixture body to stud in outlet box.
b. Carry fixture weight to structure and provide horizontal bracing from suspension points to ceiling framing to prevent sideways shifting. Provide diagonal seismic restraint wires per code.

3. Feed Point:

a. Flat-plate canopy to cover outlet box, with holes for support cable and power cord, concealed fasteners to permit splice inspection after installation.
b. At the electrified connection provide straight cord feed. Where emergency feed is required, a separate feed point shall be provided.
c. Power cord: white multi-conductor cord, parallel to support cable (aircraft cable); within pendant (rigid pendant); or flexible conduit (chain hanger).
d. Where emergency feed is required, a separate feed point shall be provided.

4. Non-feed Points:

a. 13mm (1/2") o.d. polished chrome end sleeve, inside threaded 1/4"-20, with 50mm (2") diameter. Flat white plate to cover hole in ceiling. Top of cable with ball swaged on end, to fit inside sleeve.
b. Contractor to provide support above ceiling as required.

5. Suspension method shall allow adjustment to be made in hanging length to allow for variance in ceiling height.
6. All exposed paintable suspension components shall have the same finish and color as the luminaire housing.

2.9 COMPACT FLUORESCENT LUMINAIRES

A. Dimensions: Proper for the various wattage noted on the plans and as recommended by the luminaire manufacturer or as specified.

B. Luminaire shall be designed and manufactured specifically for lamp type and configuration provided.

C. Recessed: Equip with through wire junction box. Box, ballast and replaceable components shall be accessible from the ceiling opening of the luminaire.

D. Adjustable Lamp Mechanisms: To have aiming stops which can be permanently set to position lamp vertically and rotationally.

E. Finish: All visible surfaces to be of color and texture as directed in Luminaire Schedule. All concealed interior and exterior luminaire surfaces to be matte black.

2.10 LOW VOLTAGE LUMINAIRES

A. Dimensions: Proper for the various wattage noted on the plans and as recommended by the luminaire manufacturer or as specified.

B. Recessed luminaires: Equip with protective thermal cutout and a through-wiring junction box accessible from the ceiling opening of the luminaire.

C. Adjustable Lamp Mechanisms: To have aiming stops which can be permanently set to position lamp vertically and rotationally.

D. Transformers: To provide proper lamp voltage to low voltage lamps.

1. Integral:

a. Magnetic: Encapsulated for silent operation, securely mounted to the luminaire and removable through the aperture for hard ceiling installations or remote where shown on drawings.
b. Electronic: Electronic transformers shall not be provided unless directed in the Luminaire Schedule.

E. Finish: All visible surfaces to be of color and texture as directed in Luminaire Schedule. All concealed interior and exterior luminaire surfaces to be matte black.

2.11 LED LUMINAIRES

A. Dimensions: Proper for the various wattage noted on the plans and as recommended by the luminaire manufacturer or as specified.

B. Recessed luminaires: Must be rated for use in recessed applications. If required by the owner or design team, the manufacturer must produce test data proving the product is rated for use in recessed applications.

C. CRI: luminaires shall have a minimum Color Rendering Index (CRI) of 80 or higher.

D. Color temperature shall be per the luminaire schedule. The color temperature shall not exceed a +/- tolerance of greater than 2 McAdam Elipses. Over the life of the luminaire.

E. Adjustable Lamp Mechanisms: To have aiming stops which can be permanently set to position lamp vertically and rotationally.

F. Power Supply

1. Integral:

a. Rated for use with the LED array specified. Warranty array and driver as an assembly. 5 year full replacement, non-pro rated warranty is required on all electronic components.

2. Remote:

a. Rated for use with the LED array specified. Warranty array and driver as an assembly. 5 year full replacement, non-pro rated warranty is required on all electronic components.

G. Finish: All visible surfaces to be of color and texture as directed in Luminaire Schedule. All concealed interior and exterior luminaire surfaces to be matte black or as recommended by the luminaire manufacturer.

H. Testing: LED luminaires must meet the IES LM-79-08 and LM 80-08 testing requirements. The manufacturer shall provided verification of testing compliance upon request of the design team, contractor or owner.

I. Disposal and replacement: The LED manufacturer is responsible for the disposal of expired LED arrays and heat sinks. The fixture must be clearly labeled with return information, disposal procedures and manufacturer disposal contact information. All shipping will be paid for by the owner.

1. The manufacturer is required to inform the owner of new power requirements and /or lumen output values if new replacement components prior to shipping replacement parts.
2. Disposal and replacement information will be labeled inside the luminaire and in the project operation and maintenance manuals along with all O&M requirements listed in Division 1 of the specifications.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall meet the general requirements of NFPA 70, National Electric Code.

B. Mounting heights specified on drawings:

1. Wall mounted luminaires: shall be to centerline of luminaire.
2. Pendant mounted luminaires: shall be to bottom of luminaire unless specifically identified in the Luminaire Schedule or on drawings.

C. Support:

1. The luminaires shall be supported by separate means from the building structure and not from the ceiling system, ductwork, piping or other systems.
2. The final decision as to adequacy of support and alignment will be given by the Architect.

D. Level luminaires, align in straight lines, and locate as shown on the architectural elevations and reflected ceiling plan.

E. Manufacturer's labels or monograms shall not be visible after luminaire is installed, but must be included for future reference.

F. When lamping tungsten halogen luminaires use silk gloves to insert lamps.

G. Tungsten halogen luminaires shall not be energized during construction to prevent dust build up on lamp, socket and lamp chamber. Lamping shall occur as last stage of construction.

H. Recessed luminaires shall have trims which fit neatly and tightly to the surfaces in which they are installed without light leaks or gaps. Where necessary, install heat resistant non-rubber gaskets to prevent light leaks or moisture from entering between luminaires trim and the surface to which they are mounted.

3.2 COORDINATION OF WORK

A. The Architectural Reflected Ceiling Plans shall take preference as to the exact placement of the luminaires in the ceiling.

B. Determine ceiling types in each area and provide suitable accessories and mounting frames where required for recessed luminaires. Luminaire catalog numbers do not necessarily denote specific mounting accessories for type of ceiling in which a luminaire may be installed.

3.3 AIMING

A. Aim luminaires with proper lamps installed.

B. Aim all directional luminaires, including but not limited to luminaires described in the Contract Documents or by the luminaire manufacturer as "aimable," "adjustable," or "asymmetric" as follows:

1. To provide the lighting pattern for which the luminaire is designed.
2. To provide the lighting pattern as shown on the drawings.
3. To predetermined aiming points as shown on the drawings.
4. Where aiming cannot be determined, request, in writing, clarification from the Architect, indicating luminaires needing clarification.

C. Re-aim luminaires as determined by Architect during final project walkthrough.

D. Adjustable luminaires shall be installed with “dead” zone of rotation away from intended aiming point.

3.4 PROJECT CLOSEOUT

A. Leave luminaires clean at the time of acceptance of the work. If luminaires are deemed dirty by the Architect at completion of the work, the Contractor shall clean them at no additional cost. Protective plastic wrap is to be removed from parabolic luminaires just prior to owner acceptance.

B. Provide fixtures with new lamps all operating at time of final acceptance. Exception: For fluorescent dimming fixtures, provide minimum 100 hour/maximum 200 hour, continuously lit lamps or per ballast manufacturer’s recommendations.

C. Where incandescent lamps are used for construction lighting, the lamps shall be replaced with new lamps just prior to occupancy by the owner.

END OF SECTION 265000

SECTION 271000 – STRUCTURED CABLING

PART 1 - GENERAL

1.1 SCOPE

A. This document describes general scope, products and execution requirements relating to furnishing and installing the internal Telecommunications Cabling for Veneta Elementary School.

B. Backbone and horizontal cabling comprised of Copper and Fiber Cabling, and support systems are covered under this document. All installations are to be warranted by approved manufacturers specified herein, prior to installation.

C. The Horizontal (workstation) Cabling System shall consist of a minimum of (4) Category 64-pair Unshielded Twisted Pair (UTP) Copper Cables to each work area outlet unless otherwise noted for specific locations.

D. All cables and related pathways, supports, terminations, and grounding hardware shall be furnished, installed, wired, tested, labeled, and documented by the Telecommunications Contractor as detailed in this document.

E. Product specifications, general design considerations, and installation guidelines are provided in this document. Quantities of telecommunications outlets, typical installation details, cable routing and outlet types will be provided as project specific information by bid specification and/or bid drawings. The Contractor shall meet or exceed all requirements for any infrastructure system as detailed within this document. This document shall be referenced within the projects specific scope of work.

F. This document does not replace any code, either partially or wholly. The contractor must be aware of local codes that may impact any project.

1.2 REGULATORY REFERENCES

A. All work and materials shall conform in every detail to the rules and requirements of the National Fire Protection Association, the local Electrical Code and present manufacturing standards.

B. All materials shall be UL Listed and shall be marked as such. If UL has no published standards for a particular item, then other national independent testing standards shall apply and such items shall bear those labels. Where UL has an applicable system listing and label, the entire system shall be so labeled.

C. The cabling system described in this is derived from the recommendations made in recognized telecommunications industry standards. The most recent versions of the following documents are incorporated for reference:

1. ANSI/TIA/EIA - 568-B.1, Commercial Building Telecommunications Cabling Standard Part 1: General Requirements.
2. ANSI/TIA/EIA - 568-B.2, Commercial Building Telecommunications Cabling Standard Part 2: Balanced Twisted-Pair Cabling Components.
3. ANSI/TIA/EIA - 568-B.3, Commercial Building Telecommunications Cabling Standard Part 3: Optical Fiber Cabling Components.
4. ANSI/TIA/EIA – 569-B, Commercial Building Standard for Telecommunications Pathways and Spaces.
5. ANSI/TIA/EIA – 570-B, Residential Telecommunications Cabling Standard.
6. ANSI/TIA/EIA – 606-B, Administration Standard for Telecommunications Infrastructure of Commercial Buildings.
7. ANSI/TIA/EIA – 607-B, Commercial Building Grounding and Bonding Requirements for Telecommunications.
8. ANSI/ TIA/EIA – 758, Customer-Owned Outside Plant Telecommunications Cabling Standard.
9. IEC 60794-2-11:2005: Detailed specification for simplex and duplex cables for use in premises cabling.
10. IEC 60794-2-21:2006 Detailed specification for multi-fibre optical distribution cables for use in premises cabling.
11. IEC 60794-3-12:2006: Detailed specification for duct and directly buried optical telecommunication cables for use in premises cabling.
12. IEC 60794-3-21:2006: Detailed specification for optical self-supporting aerial telecommunication cables for use in premises cabling.
13. BICSI (Building Industries Consulting Services International) - Telecommunications Distribution Methods Manual (TDMM) .
14. National Fire Protection Agency (NFPA – 70), National Electrical Code (NEC) -2008.
15. ANSI/TIA/EIA – 729, Screened, 100 ohm Twisted Pair Cabling.
16. National Fire Protection Agency (NFPA – 70), National Electrical Code (NEC).

D. If this document and any of the documents listed above are in conflict, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to the most recent release when developing the proposal for installation.

1.3 WORK INCLUDED

A. Contractor work consists of furnishing all labor, equipment, materials, and supplies and performing all operations necessary to complete the installation of a structured cabling system in compliance with the specifications and drawings.

B. The Work shall include, but not be limited to the following:

1. Furnish and install a complete telecommunications wiring infrastructure and ANSI/TIA/EIA 607-B compliant Grounding and Bonding system as specified in 27 05 26 Grounding AND Bonding for Communications systems.
2. Furnish, install, test and label all UTP and Optical Fiber cables, splice cables, 110 IDC termination blocks, interdict, ports, faceplates, inserts, connector panels and patch panels.
3. Furnish and install all racks, cabling supports, work area outlets, inserts, patch panels, and patch cords (when specified).
4. Furnish all material and labor required to form a complete system.
5. Perform link and channel testing (100% of horizontal and/or backbone links/channels) and certification of all components.
6. Furnish test results of all cabling to the Architect and the Owner in electronic format, listed by each communication closet, then by workstation ID. Test results shall be tabbed per Equipment Room.
7. Provide Owner training and documentation. (Testing documentation and As-built drawings).

1.4 SUBMITTALS

A. General:

1. Work shall not proceed without Architect and Owner approval of the submitted items.
2. The guidelines set forth in this section pertain to all Division 27 specifications included in this project.
3. The following guidelines and deliverables shall be submitted to the Owner and Architect prior to installation commencement.
4. Submit all proposed products for use in communications systems in accordance to the guidelines set forth herein.

B. Informational Submittals:

1. Proposed labeling examples for Patch Panels, Faceplates and Work Area Outlet jacks.
2. Field Test Reports: Submit sample cable test reports showing report format and parameters tested.
3. Optical loss budget calculations for each optical fiber run.
4. Proposed test forms for fiber backbone, copper backbone and horizontal UTP cable.
5. Certificates:

    a. Name(s) and copy of certificate of RCDD’s.
    b. Certify that field tests have been performed and that work meets or exceeds specified requirements.

c. Certify that factory tests have been performed and that work meets or exceeds specified requirements. Certificates may be based on recent or previous test results, provided material or products tested are identical to those proposed for this Project.
d. Optical loss budget calculations for each optical fiber run.
e. Calibration report of test equipment for fiber and copper. Last calibration date should not be older than 1 year from the 1st day of testing.

C. Shop Drawings:

1. The Drawings that accompany this Division 27 Specifications are diagrammatic. They do not show every offset, bend, tee, or elbow which may be required to install work in the spaces provided and avoid conflicts. Offsets and transitions shall be assumed at a minimum at each duct crossing, structural penetrations through shear walls or beams, structural grids where ceiling heights are restricted. Follow the contract drawings as closely as is practical to do so and install additional bends, offsets and elbows where required by local conditions from measurements taken at the Building, subject to approval, and without additional cost to the Owner. The right is reserved to make any reasonable changes in outlet location prior to roughing-in, without cost impact.

a. Plan views and elevations of telecommunication spaces showing cabinets, racks, termination blocks, patch panels, wire managers and cable pathways.
b. Vertical and horizontal offsets and transitions.
c. Clearances for access above and to side of cable trays.
d. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
e. Plan view and elevations of all raceways (conduits, cable trays, ladder racks, floor ducts, junction boxes, pull boxes, splice boxes, manholes, and all associated supports).
f. Backbone diagram(s) for fiber and copper telecommunication cables.
g. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
h. The telecommunications drawings shall be identified as Technology (T-drawings).

D. The Contract Drawings indicate the general layout of the Cable Tray, major communications pathways, and various items of equipment. Coordination with other trades and with field conditions will be required. For this purpose, prepare Shop Drawings of all equipment installations. Shop Drawings shall be new drawings prepared by Contractor and not reproductions or tracings of Architect's Drawings. Overlay drawings with shop drawings of other trades and check for conflicts. All drawings shall be same size as Architect's Drawings with title block similar to Contract Drawings and identifying Architect's drawing number or any reference drawings. All drawings shall be fully dimensioned including both plan and elevation dimensions. Shop drawings cannot be used to make scope changes.

E. Equipment / Products:

1. Submit at one time all related submittals for the products called out in all Division 27 contract specifications.
2. Two indexed sets of manufacturer's technical data for each product including product description, specifications including labeling or listing by an agency acceptable to the Owner, and storage requirements.
3. Where more than one product is called out on the same sheet, clearly highlight or mark which product is proposed for use.

F. Firestop design basis documentation that shall include each type of communication penetration, type of building construction being penetrated including the hourly resistance rating of floor, wall, or other partition of building construction into which Firestop design will be installed, and Firestop device or system proposed for use.

G. All submittals shall be approved by Owner authorized representative before installation implementation.

H. Project Closeout

1. Manufacturer's Installation, Start-Up and Adjustment Instructions.
2. Operation and Maintenance Data.
3. Special Warranty: Contractor shall not offer a special warranty to owner to supplement the standard warranty requirement covered in this specification.

    a. With respect to the installation of Approved Manufacturers cabling system, furnish Approved Manufacturers Cabling System application / system standard warranty.

I. The Telecommunications Contractor shall receive written approval from the Architect and Owner on all substitutions of material. No substituted materials shall be installed except by written approval from the Architect and Owner's authorized representative. Substitution requests shall be made in writing prior to bid closing as required by the solicitation documents, but in no case less than five working days before bid closing. Requests for substitution shall also have manufacturer product specification sheets along with any cost changes attached for every product being requested. The Architect and Owner reserve the right to approve or deny requests at their discretion.

J. All substitution requests shall be submitted under the guidelines set forth in Division 1 documents.

K. The Category 6 portion of the cabling system shall comply with the proposed link and channel performance requirements of the latest revision of ANSI/TIA-568-C.1 "Performance Specifications for 4-pair 100 Ohm Category 6 Cabling". The system warranty shall be facilitated by the Contractor and be established between the Customer and the cabling system manufacturer. Contractor derived warranties will not be accepted.

PART 2 - PRODUCTS

2.1 PREMISE CABLING

A. FIBER OPTIC RISER CABLE:

1. Multimode Cable:

a. Install all fiber runs within 1" CMR rated corrugated inner duct.
b. CMP Rated Cable.
c. Strand Count: 12.
d. Fiber Dimensions: 62.5micron core, 125micron cladding buffering.
e. Fiber grade: OM4.
f. Approved Manufacturer.

1) Panduit
2) Corning.
3) General Cable.

2. Singlemode Cable:

a. Install all fiber runs within 1" CMR rated corrugated inner duct.
b. CMP Rated Cable.
c. Strand Count: 6.
d. Fiber Dimensions: 8.3micron core, 125micron cladding buffering.
e. Approved Manufacturer.

1) Panduit
2) Corning.
3) General Cable.

2.2 FIBER OPTIC CONNECTORS:

1. Terminate singlemode fiber ends with MTRJ ceramic ferrule connectors.
2. Terminate multimode fiber ends with MTRJ ceramic ferrule connectors.

2.3 OPTICAL FIBER SUPPORTS

A. 2 RU Fiber Patch Panel fully equipped with coupling panels and LC couplers. Complete with labels, jumper retainers and 19" rack adapters.

1. Capable of housing 48 fiber terminations.

B. Category 6 Horizontal Cable – Wall outlets

1. Horizontal cabling shall be 22-24 AWG, 4-pair UTP, UL/NEC/NFPA CMP rated.
2. Cable jacketing shall be lead-free.
3. Cable shall be 3rd party verified to ANSI/TIA/EIA-568-B.2.1 and meet the performance requirements listed in the table below in addition to all other standard Category 6 performance requirements. Cable shall be safety listed to ANSI/UL 1666.
4. Where cabling is located in wet locations or below-grade areas provide wet location cabling.
5. Color: White.

    a. Approved Manufacturers:

        1) Panduit.
        2) Mohawk.
        3) Belden.

C. Category 6A Horizontal Cable – Ceiling outlets (WAP and projector locations)

1. Horizontal cabling shall be 22-24 AWG, 4-pair UTP, UL/NEC/NFPA CMP rated.
2. Cable jacketing shall be lead-free.
3. Cable shall be 3rd party verified to ANSI/TIA/EIA-568-B.2.1 and meet the performance requirements listed in the table below in addition to all other standard Category 6 performance requirements. Cable shall be safety listed to ANSI/UL 1666.
4. Where cabling is located in wet locations or below-grade areas provide wet location cabling.
5. Color: Green.

    a. Approved Manufacturers:

        1) Panduit.
        2) Mohawk.
        3) Belden.

2.4 TELECOMMUNICATIONS TERMINATION RACK

A. Distribution Rack.

1. Heavy-duty aluminum extruded upright channels, bases and top angles.
2. 19-inch wide rack mounts.
3. Mounting holes tapped #12-24 on standard EIA-310 spacing.
4. Supplied with two top angles for additional strength and (50) mounting screws.
5. Designed with web channel holes to allow multiple racks to be mounted side by side.
6. Includes assembly and floor mounting hardware;

a. Manufacturer:

1) Chatsworth Products, Inc.
2) Great Lakes.

2.5 PUNCH DOWN BLOCKS:

A. Riser termination:

1. Designed to field terminate 100pr.
2. Includes C5 clips for termination.
3. Wall mounted 110 Connecting Block with legs.

B. Approved Manufacturer:

1. Panduit.
2. Belden.

2.6 MODULAR JACK FACEPLATES:

A. Wall mounted Faceplates:

1. Faceplates shall be constructed of ABS molding compound and be 4.53” X 2.77” X .60” in size. Each faceplate shall contain four jack ports. Each port shall be provided with an icon to indicate its function.
2. Faceplates shall accommodate two labels and provide a clear polycarbonate cover for each.
3. Provide blank inserts for all unpopulated ports.
4. Faceplates shall be Ivory.

B. Floor box and Pedestal Faceplates:

1. Coordinate Floor box pathways and terminations with Electrical contract specifications.
2. Provide faceplate capable of terminating required number of modular jacks.
3. Provide faceplate compatible with activation of in floor pedestal where specified.

C. Modular Furniture Faceplates:

1. Provide faceplate capable of terminating required number of modular jacks.
2. Provide faceplate compatible with activation of modular furniture.

D. Approved Manufacturer:

1. Panduit.
2. Belden.

2.7 MODULAR JACK OUTLETS:

A. All modular jacks shall be wired to the T568B wiring pattern.

B. Modular jacks shall be terminated using a 110-style pc board connector (made of 94V-0 rated polycarbonate), color-coded for both T568A and T568B wiring. The 110 connector shall terminate 22-24 AWG solid conductors with a maximum insulation diameter of .050 inches.

C. Category 6 modular (data) jacks shall be unkeyed 4-pair and shall meet the performance requirements listed in the table below. Modular jacks shall fit in a .790" X .582" opening. Modular jacks shall be terminated using a 110-style pc board connector, color-coded for both T568A and T568B wiring. Each jack shall be wired to T568B.

D. Color: Ivory

2.8 CATEGORY 6 PATCH PANELS:

A. Patch panels shall be 3.5 inches high and provide 48 modular jack ports, wired to T568B. Patch panel modular jacks shall be configured as 6-port, replaceable modules. The front of each module shall be capable of accepting 9mm to 12mm labels.

B. Each port shall be capable of accepting an icon to indicate its function.

C. Patch panels shall terminate the building cabling on 110-style insulation displacement connectors.

D. Patch panels shall comply with the performance characteristics listed in the following table. Patch panels must be UL Listed.

1. Approved Manufacturer:

a. Panduit.
b. Belden.

2.9 HORIZONTAL CABLE MANAGEMENT PANELS

A. 2 RU wire management module.

B. Cable management shall be installed above and below all patch panels and active components.

C. Do not interfere with panels mounted above or below.

2.10 PATCH PANEL CABLE MANAGEMENT SUPPORT BAR:

A. Do not interfere with panels mounted above or below.

2.11 PATHWAY SYSTEMS

A. The contractor is responsible for providing all pathway systems to provide the owner a complete and functional system.

B. Ladder Rack Cable Tray:

1. Shall be installed in all telecommunications equipment rooms.

a. 12" Wide Cable Runway.
b. Tubular construction for weight savings.
c. High strength welded construction.
d. The most popular sizes available standard.
e. Constructed from 3/8" x 1-1/2" x .065" wall rectangular steel tubing.
f. Cross members are welded on 12" centers.
g. Length of 10’.

C. Approved Manufacturers:

1. Cooper B-Line.
2. Legrand.
3. CPI.

D. Wire Mesh (Basket) Tray

1. Shall be installed as shown on the drawings in all areas outside telecommunications rooms.
2. Pre-galvanized trays shall be UL Classified in the United States. Painted tray shall be UL Classified in the United States and Canada.
3. Wire mesh cable tray shall be zinc electroplated after fabrication, galvanized before fabrication (pre-galvanized) or painted black with powder coat paint, as required.
4. Individual tray sections shall be 10’ (3048 mm) long 12” (300 mm), wide. Sidewalls shall be 4” (100 mm).

E. Approved Manufacturers

1. Cooper B-Line.
2. Legrand.
3. CPI.

F. Cable Runway Radius Drop:

1. Provides 3” bend radius.
2. Fits 12" cable runway made from 1-1/2" x 3/8" tubing.
3. Usable on tubular or solid type cable runway.
4. Easy installation using a simple bolt on method.

G. Cable Runway Grounding Kit:

1. Each kit contains:
2. (2)12-24 x 3/4" screws.
3. (2)12-24 hex nuts.
4. (4)#12 split washers.
5. (1)8" copper braid ground strap.

2.12 FIRESTOPPING SYSTEMS

A. The contractor is responsible for providing all firestopping systems as shown on the drawings or as required as specified by the mechanical and architectural egress plans.

B. Firestops shall provide F ratings, which meet or exceed those specified in Architectural plans.

C. Firestops shall be provided with the same usable area as the open pathway system it is serving.

D. All firestopping systems used for communications cabling use shall be reusable type and provide access to all cabling through it.

E. Cementitous firestopping systems are not permitted for communications use.

1. Approved Manufacturers:

a. STI – EZ-Path.
b. Hilti – CPS.

2.13 MISCELLANEOUS MATERIALS:

A. Screws, nuts, bolts, washers, tools, sealants, sleeves, fire stop, riser collars, rack anchors, ground clips and ground wire, backboards, mushrooms, wire minders, D-brackets, labeling materials, etc., as required to provide a trim and working, turnkey system that conforms to all applicable codes and regulations.

PART 3 - EXECUTION

3.1 GENERAL

A. Perform all installation work in a neat, high quality manner and in conformity with local and federal building codes.

B. Cable routes must be field engineered to avoid obstruction by ducts and other material in the ceiling space.

C. Fire stop all core holes and sleeves used for riser and tie cable installation between floors or through fire-rated walls.

D. Place cables with sufficient bending radius so as not to degrade signal carrying capacity nor to kink, shear, or damage outside sheath.

E. Manufacturer's pulling tension specifications must be adhered to for installing cable so as not to stretch cable or reduce optical performance characteristics.

F. Place all optical fiber cables in innerduct in conduit systems, in cable tray locations and in exposed areas of the ER's.

G. Use of existing ceiling wires, plumbing, conduits, sprinkler pipes, or air handling structures for attachment of cables is expressly prohibited.

H. Maintain at least 12 inches separation between all unshielded copper communications cables and light fixtures or parallel runs of conduit containing power cables.

I. Ceiling tiles broken or defaced by the cabling installer during the installation and testing process must be replaced to the satisfaction of the Owner.

J. Advise the Engineer immediately of any conditions that might delay or impede cable installation or affect the quality of the installed cable plant. Proceed with questionable segment only after the Engineer has had the opportunity to review those conditions.

K. All cable runway must be bonded according to manufacturer specifications and grounded using green, insulated #6 AWG wire to the appropriate ground bar in each MDF/ER.

L. All racks must be grounded using green, insulated #6 AWG wire to the appropriate ground bar in each MDF/ER.

3.2 FIELD EXAMINATION

A. Outlet locations and other dimensions on the Electrical and Cabling drawings are only approximate. Verify locations and routes by inspecting the site prior to installation.

3.3 SITE PREPARATION

A. It will be the responsibility of the cabling installer to keep the work area free of debris, trash, empty cable reels, scrap wire, etc., and to dispose of these materials on a daily basis.

3.4 INSTALLATION

A. Category 6 Horizontal Station Cables:

1. Install 4-pair Category 6 cables between the appropriate ER and each outlet as shown on the drawings. Route these cables to the ER using conduit and/or install support wires to structure as necessary in the ceiling space. At the station end, terminate each Category 6 cable on a Category 6 jack and install in an appropriate faceplate. At the ER end, terminate the station cables in sequential order on Category 6 110-type patch panel on equipment racks. Comply with a cable numbering sequence provided by Owner. The actual number of 4-pair Category 6 cables required at each outlet are indicated on the drawings.
2. Install Category 6 patch panels on rack-mounted racks in each ER as required to accommodate the station pairs routed to each ER room.
3. Comply with all installation practices listed in EIA/TIA 568 B.2-1 guidelines.
4. Terminate all horizontal cable to T568B standard.
5. In terminating Category 6 cables, the amount of untwisting on each pair must be limited to 0.5 inches.
6. The amount of untwisting of jumper wire must also be limited to 0.5 inches.
7. Strip back only as much of the jacket of any Category 6 cable as is necessary to administer connecting hardware terminations.
8. Prescribed pulling tensions must be observed for all cables installed.
9. Cable bundles must be tie wrapped with minimum cinching pressure so as not to compress the dielectric.
10. Cable bend radii must be limited to eight times the cable diameter. This means that care must be taken not to kink the cable during installation, as a kink by definition violates the minimum bending radius of the cable.
11. Bend radius for cable bundles must be limited to eight times the diameter of the cable bundle.

3.5 TESTING

A. Horizontal Station Cabling:

1. Test 100% of the Category 6 station cables for full electrical compliance with Category 6 (powersum) standards published by the EIA/TIA 568 B.2-1 using Level III tester approved by the Owners approved representative. Replace any cables that cannot meet Category 6 specifications and retest as directed by the Owners approved representative.

3.6 LABELING

A. Each cable must bear secure labels which clearly identify its cable number. See drawings for labeling scheme. Each station cable must be labeled on the jacket at each end and on the jack faceplate at the station end. Contractor must be able to produce labels having up to 20 alphanumeric characters, including dashes, dots, and parentheses.

B. Number the station cables based on their patch panel termination, panel one being 001 through 048, panel two 049 through 096 and so on. At the faceplate the outlet would be labeled for each cable and which ER it is fed from; for example: The first faceplate fed from the ER would be 01-001, 01-002, 01-003. Cables from the 2nd Floor ER would be 02-001, 02-002, 02-003.

1. Label location must be as follows:

a. Station Cables: Within 2" of the end of outer jacket and above each station jack with a mechanically produced label.
b. Riser Cables: Within 6" of the end of the outer jacket on each fiber and copper cable with 1" labels.

END OF SECTION 271000

SECTION 321216 - ASPHALT PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Cold milling of existing asphalt pavement.
2. Hot-mix asphalt patching.
3. Hot-mix asphalt paving.
4. Hot-mix asphalt overlay.

B. Related Requirements:

1. Section 024119 "Selective Demolition" for demolition and removal of existing asphalt pavement.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 INFORMATIONAL SUBMITTALS

A. Product Data: For each type of product. Include technical data and tested physical and performance properties.
1. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the work.
2. Job-mix Designs: For each job mix proposed for the Work

1.5 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of Section 0744 of the 2015 Oregon Standard Specifications for Construction for asphalt paving work for asphalt paving work.

1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

1.6 FIELD CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:
   1. Tack Coat: Minimum surface temperature of 60 deg F (15.6 deg C).
   2. Slurry Coat: Comply with weather limitations in ASTM D 3910.
   3. Asphalt Base Course: Minimum surface temperature of 40 deg F (4.4 deg C) and rising at time of placement.
   4. Asphalt Surface Course: Minimum surface temperature of 60 deg F (15.6 deg C) at time of placement.

PART 2 - PRODUCTS

2.1 AGGREGATES

A. General: Conform to the requirements of 00744 of the 2015 Oregon Standard Specifications for construction.

2.2 ASPHALT MATERIALS

A. Asphalt Binder: AASHTO M 320, PG 64-22.

B. Tack Coat: ASTM D 977 or AASHTO M 140 emulsified asphalt, or ASTM D 2397 or AASHTO M 208 cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.

C. Water: Potable.

2.3 AUXILIARY MATERIALS

A. Recycled Materials for Hot-Mix Asphalt Mixes: Reclaimed asphalt pavement; reclaimed, unbound-aggregate base material; and recycled tires asphalt shingles or glass from sources and gradations that have performed satisfactorily in previous installations, equal to performance of required hot-mix asphalt paving produced from all new materials.

B. Herbicide: Commercial chemical for weed control, registered by the EPA, and not classified as "restricted use" for locations and conditions of application. Provide in granular, liquid, or wettable powder form.

C. Paving Geotextile: AASHTO M 288 paving fabric; nonwoven polypropylene; resistant to chemical attack, rot, and mildew; and specifically designed for paving applications.

2.4 MIXES

A. Hot-Mix Asphalt: Dense-graded, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction and complying with the following requirements:

1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
2. Base Course: Level 2, ½" dense, HMAC.
3. Surface Course: Level 2, ½" dense, HMAC.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that subgrade is dry and in suitable condition to begin paving.

B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

C. Proceed with paving only after unsatisfactory conditions have been corrected.

3.2 COLD MILLING

A. Clean existing pavement surface of loose and deleterious material immediately before cold milling. Remove existing asphalt pavement by cold milling to grades and cross sections indicated.
1. Mill to a uniform finished surface free of excessive gouges, grooves, and ridges.
2. Patch surface depressions deeper than 1 inch (25 mm) after milling, before wearing course is laid.
3. Keep milled pavement surface free of loose material and dust.
4. Do not allow milled materials to accumulate on-site.

3.3 PATCHING

A. Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches (300 mm) into perimeter of adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.

B. Portland Cement Concrete Pavement: Break cracked slabs and roll as required to reseat concrete pieces firmly.
1. Remove disintegrated or badly cracked pavement. Excavate rectangular or trapezoidal patches, extending into perimeter of adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Recompact existing unbound-aggregate base course to form new subgrade.

C. Tack Coat: Before placing patch material, apply tack coat uniformly to vertical asphalt surfaces abutting the patch. Apply at a rate of 0.05 to 0.15 gal./sq. yd. (0.2 to 0.7 L/sq. m).

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

D. Placing Patch Material: Fill excavated pavement areas with hot-mix asphalt base mix for full thickness of patch and, while still hot, compact flush with adjacent surface.

3.4 SURFACE PREPARATION

A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.

B. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.

C. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd. (0.2 to 0.7 L/sq. m).

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.5 PLACING HOT-MIX ASPHALT

A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand in areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.
1. Spread mix at a minimum temperature of 250 deg F (121 deg C).
2. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

B. Place paving in consecutive strips not less than 10 feet (3 m) wide unless infill edge strips of a lesser width are required.

C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.6 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.

1. Clean contact surfaces and apply tack coat to joints.
2. Offset longitudinal joints, in successive courses, a minimum of 6 inches (150 mm).
3. Offset transverse joints, in successive courses, a minimum of 24 inches (600 mm).
4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method according to AI MS-22, for both "Ending a Lane" and "Resumption of Paving Operations."
5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.

3.7 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.

1. Complete compaction before mix temperature cools to 185 deg F (85 deg C).

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:
1. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent or greater than 96 percent.

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.

G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.8 INSTALLATION TOLERANCES

A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:

1. Base Course: Plus or minus 1/2 inch (13 mm).
2. Surface Course: Plus 1/4 inch (6 mm), no minus.

B. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot (3-m) straightedge applied transversely or longitudinally to paved areas:

1. Base Course: 1/4 inch (6 mm).
2. Surface Course: 1/8 inch (3 mm).

3.9 FIELD QUALITY CONTROL

A. Testing Agency: Contractor will engage a qualified testing agency to perform tests and inspections.

B. Replace and compact hot-mix asphalt where core tests were taken.

C. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.10 WASTE HANDLING

A. General: Except for material indicated to be recycled, remove excavated materials from Project Site and legally dispose of them in an EPA-approved landfill.

END OF SECTION 321216

SECTION 321313 - CONCRETE PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes Concrete Paving.
   1. Curbs and gutters.
   2. Walks.

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash, slag cement, and other pozzolans.

B. W/C Ratio: The ratio by weight of water to cementitious materials.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

   1. Require representatives of each entity directly concerned with concrete paving to attend, including the following:

      a. Contractor's superintendent.
      b. Independent testing agency responsible for concrete design mixtures.
      c. Ready-mix concrete manufacturer.
      d. Concrete paving Subcontractor.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1.6 INFORMATIONAL SUBMITTALS

A. Material Certificates: For the following, from manufacturer:

1. Cementitious materials.
2. Steel reinforcement and reinforcement accessories.
3. Fiber reinforcement.
4. Admixtures.
5. Curing compounds.
6. Applied finish materials.
7. Bonding agent or epoxy adhesive.
8. Joint fillers.

1.7 QUALITY ASSURANCE

A. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").

B. Testing Agency Qualifications: Qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.

C. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Build mockups of full-thickness sections of concrete paving to demonstrate typical joints; surface finish, texture, and color; curing; and standard of workmanship.
2. Build mockups of concrete paving in the location and of the size indicated or, if not indicated, build mockups where directed by Architect and not less than 96 inches (2400 mm) by 96 inches (2400 mm) Insert dimensions.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified independent testing agency to perform preconstruction testing on concrete paving mixtures.

1.9 FIELD CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

B. Cold-Weather Concrete Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:

1. When air temperature has fallen to or is expected to fall below 40 deg F (4.4 deg C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F (10 deg C) and not more than 80 deg F (27 deg C) at point of placement.
2. Do not use frozen materials or materials containing ice or snow.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.

C. Hot-Weather Concrete Placement: Comply with ACI 301 (ACI 301M) and as follows when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F (32 deg C) at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Cover steel reinforcement with water-soaked burlap, so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

A. ACI Publications: Comply with ACI 301 (ACI 301M) unless otherwise indicated.

2.2 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.

1. Use flexible or uniformly curved forms for curves with a radius of 100 feet (30.5 m) or less.

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

2.3 STEEL REINFORCEMENT

A. Epoxy-Coated Welded-Wire Reinforcement: ASTM A 884/A 884M, Class A, plain steel.

B. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420); deformed.

C. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 (Grade 420) plain-steel bars. Cut bars true to length with ends square and free of burrs.

D. Tie Bars: ASTM A 615/A 615M, Grade 60 (Grade 420); deformed.

E. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded-wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified, and as follows:

1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.
2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.

2.4 CONCRETE MATERIALS

A. Cementitious Materials: Use the following cementitious materials, of same type, brand, and source throughout Project:

1. Portland Cement: ASTM C 150/C 150M, gray portland cement Type I/II.
2. Fly Ash: ASTM C 618, Class C.
3. Slag Cement: ASTM C 989/C 989M, Grade 100 or 120.

B. Normal-Weight Aggregates: ASTM C 33/C 33M, Class 4S, uniformly graded. Provide aggregates from a single source.

1. Maximum Coarse-Aggregate Size: 1 inch (25 mm) nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Air-Entraining Admixture: ASTM C 260/C 260M.

D. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
2. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
3. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.

E. Water: Potable and complying with ASTM C 94/C 94M.

2.5 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) dry or cotton mats.

B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

D. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.

F. White, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 2, Class B, dissipating.

2.6 RELATED MATERIALS

A. Joint Fillers: ASTM D 1751, asphalt-saturated cellulosic fiber in preformed strips.

B. Epoxy-Bonding Adhesive: ASTM C 881/C 881M, two-component epoxy resin capable of humid curing and bonding to damp surfaces; of class suitable for application temperature, of grade complying with requirements, and of the following types:

2.7 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to ACI 301 (ACI 301M), for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.

1. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.
2. When automatic machine placement is used, determine design mixtures and obtain laboratory test results that comply with or exceed requirements.

2.8 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Furnish batch certificates for each batch discharged and used in the Work.

1. When air temperature is between 85 and 90 deg F (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

B. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.

1. Completely proof-roll subbase in one direction. Limit vehicle speed to 3 mph (5 km/h).
2. Proof-roll with a pneumatic-tired and loaded, 10-wheel, tandem-axle dump truck weighing not less than 15 tons (13.6 tonnes).
3. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch (13 mm) according to requirements in Section 312000 "Earth Moving."

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.4 STEEL REINFORCEMENT INSTALLATION

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

3.5 JOINTS

A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.

1. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.

1. Continue steel reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of paving strips unless otherwise indicated.
2. Provide tie bars at sides of paving strips where indicated.
3. Butt Joints: Use epoxy-bonding adhesive at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
4. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys unless otherwise indicated. Embed keys at least 1-1/2 inches (38 mm) into concrete.
5. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.

1. Locate expansion joints at intervals of 50 feet (15.25 m) unless otherwise indicated.
2. Extend joint fillers full width and depth of joint.
3. Terminate joint filler not less than 1/2 inch (13 mm) or more than 1 inch (25 mm) below finished surface if joint sealant is indicated.
4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
6. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a [**1/4-inch (6-mm)**] [**3/8-inch (10-mm)**] radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate grooving-tool marks on concrete surfaces.

2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- (3-mm-) wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.

3. Doweled Contraction Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch (6-mm) radius. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.

3.6 CONCRETE PLACEMENT

A. Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast-in.

B. Remove snow, ice, or frost from subbase surface and steel reinforcement before placing concrete. Do not place concrete on frozen surfaces.

C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

D. Comply with ACI 301 (ACI 301M) requirements for measuring, mixing, transporting, and placing concrete.

E. Do not add water to concrete during delivery or at Project site. Do not add water to fresh concrete after testing.

F. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

G. Consolidate concrete according to ACI 301 (ACI 301M) by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.

1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement dowels and joint devices.

H. Screed paving surface with a straightedge and strike off.

I. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleedwater appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

J. Curbs and Gutters: Use design mixture for automatic machine placement. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing.

K. Slip-Form Paving: Use design mixture for automatic machine placement. Produce paving to required thickness, lines, grades, finish, and jointing.

1. Compact subbase and prepare subgrade of sufficient width to prevent displacement of slip-form paving machine during operations.

3.7 FLOAT FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

1. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface, perpendicular to line of traffic, to provide a uniform, fine-line texture.

3.8 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection.

C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h (1 kg/sq. m x h) before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.

D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

E. Curing Methods: Cure concrete by moisture curing moisture-retaining-cover curing curing compound or a combination of these as follows:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

a. Water.
b. Continuous water-fog spray.
c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch (300-mm) lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover, placed in widest practicable width, with sides and ends lapped at least 12 inches (300 mm), and sealed by waterproof tape or adhesive. Immediately repair any holes or tears occurring during installation or curing period, using cover material and waterproof tape.
3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating, and repair damage during curing period.

3.9 PAVING TOLERANCES

A. Comply with tolerances in ACI 117 (ACI 117M) and as follows:

1. Elevation: 3/4 inch (19 mm).
2. Thickness: Plus 3/8 inch (10 mm), minus 1/4 inch (6 mm).
3. Surface: Gap below 10-feet- (3-m-) long; unleveled straightedge not to exceed 1/2 inch (13 mm).
4. Alignment of Tie-Bar End Relative to Line Perpendicular to Paving Edge: 1/2 inch per 12 inches (13 mm per 300 mm) of tie bar.
5. Lateral Alignment and Spacing of Dowels: 1 inch (25 mm).
6. Vertical Alignment of Dowels: 1/4 inch (6 mm).
7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Paving Edge: 1/4 inch per 12 inches (6 mm per 300 mm) of dowel.
8. Joint Spacing: 3 inches (75 mm).
9. Contraction Joint Depth: Plus 1/4 inch (6 mm), no minus.
10. Joint Width: Plus 1/8 inch (3 mm), no minus.

3.10 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Testing Services: Testing and inspecting of composite samples of fresh concrete obtained according to ASTM C 172/C 172M shall be performed according to the following requirements:

1. Testing Frequency: Obtain at least one composite sample for each 5000 sq. ft. (465 sq. m) or fraction thereof of each concrete mixture placed each day.

    a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C 231/C 231M, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.

4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F (4.4 deg C) and below and when it is 80 deg F (27 deg C) and above, and one test for each composite sample.
5. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
6. Compressive-Strength Tests: ASTM C 39/C 39M; test one specimen at seven days and two specimens at 28 days.

    a. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.

C. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi (3.4 MPa).

D. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.

F. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.

G. Concrete paving will be considered defective if it does not pass tests and inspections.

H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.11 REPAIR AND PROTECTION

A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.

B. Drill test cores, where directed by Architect, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with portland cement concrete bonded to paving with epoxy adhesive.

C. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 321313

SECTION 321723 - PAVEMENT MARKINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes painted markings applied to asphalt pavement.

B. Related Requirements:

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to marking pavement including, but not limited to, the following:

a. Pavement aging period before application of pavement markings.
b. Review requirements for protecting pavement markings, including restriction of traffic during installation period.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include technical data and tested physical and performance properties.

B. Shop Drawings: For pavement markings.

1. Indicate pavement markings, colors and dimensions to adjacent work.

C. Samples: For each exposed product and for each color and texture specified; on rigid backing, 8 inches (200 mm) square.

1.5 QUALITY ASSURANCE

1.6 FIELD CONDITIONS

A. Environmental Limitations: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 55 deg F (12.8 deg C) for water-based materials, and not exceeding 95 deg F (35 deg C).

PART 2 - PRODUCTS

2.1 PAVEMENT-MARKING PAINT

A. Pavement-Marking Paint: MPI #97, latex traffic-marking paint.

1. Color: White.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that pavement is dry and in suitable condition to begin pavement marking according to manufacturer's written instructions.

B. Proceed with pavement marking only after unsatisfactory conditions have been corrected.

3.2 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.

B. Allow paving to age for a minimum of 30 days before starting pavement marking.

C. Sweep and clean surface to eliminate loose material and dust.

D. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils (0.4 mm).

3.3 PROTECTING AND CLEANING

A. Protect pavement markings from damage and wear during remainder of construction period.

B. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 321723