

SECTION 22 05 00
COMMON WORK RESULTS FOR PLUMBING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 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.

1.03 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.

1.04 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 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 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.

1.05 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 three-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. Superplot plans of above ground work with a colored overlay of all trades including, but not limited to, HVAC piping, HVAC equipment, plumbing piping and equipment, sprinklers, lighting, lighting controls, cable tray, fire alarm devices, electrical power conduit, and ceiling system to a minimum of 1/2" = 1'-0" scale.
 - f. Beam penetration drawings indicating beam penetrations meeting the requirements indicated on the floor plans and on the structural drawings to a minimum of 1/4" = 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 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.
- 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.

1.06 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.
- D. Furnish competent engineer knowledgeable in this building system for minimum of five 8-hour days to instruct Owner in operation and maintenance of systems and equipment. Contractor shall keep a log of this instruction including dates, times, subjects, and those present and shall present such log when requested by Architect.

1.07 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.

1.08 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.

1.09 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

2.01 ACCESS PANELS

- A. Furnish under this Division as specified in 08 31 13 Access Doors and Frames.

2.02 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 Above Grade: Cast iron.

2.03 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.

2.04 MACHINERY GUARDS

- A. Furnish guards for protection on all rotating and moving parts of equipment. Provide guards for all metal fan drives and motor pulleys, regardless of being enclosed in a metal cabinet.
- B. Provide shaft holes in guards for easy use of tachometers at pulley centers. Guards shall be easily removable for pulley adjustment or removal and changing of belts.
- C. All guards shall meet OSHA requirements including back plates.

2.05 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. Motors – AC Induction:
 - 1. Motors shall be furnished as integral part of driven equipment. They shall be drip-proof induction type with ball bearings unless noted otherwise. Motors 1 HP and above shall be premium energy efficient type, except for emergency equipment motors. Motors shall be built to NEMA Standards for the service intended. The motors shall be rated for the voltage specified, suitable for operation within the range of 10 percent above to 10 percent below the specified voltage.
 - 2. Energy efficient motors shall be Baldor, Westinghouse, General Electric.

3. The motor shall meet the efficiency standards identified in the table below as determined using the IEEE Method B test at full load.

MINIMUM MOTOR EFFICIENCIES					
		RPM			
		IEEE 112B Efficiency			
HP	KW	900	1200	1800	3600
1	0.75	--	82.5	85.5	80.0
1.5	1.15	--	86.5	86.5	85.5
2	1.53	--	87.5	86.5	86.5
3	2.3	84.0	89.5	89.5	88.5
5	3.8	85.5	89.5	89.5	89.5

4. Refer to Equipment Schedules on the Drawings for motor horsepower, voltage and phase.
5. Refer to individual product sections for additional motor requirements.
6. 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.
7. All motors controlled by variable frequency drives shall be inverter duty rated and have Class F insulation or better. They shall also be able to withstand repeated voltage peaks of 1600 volts with rise times of 0.1 microseconds and greater in accordance with NEMA Standard MG1 Part 31.
8. Motors served from variable frequency drives shall be equipped with shaft grounding system which shall provide a path for current to flow between the shaft and motor frame. SGS.
- D. 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.
- E. Starters: Provided under Division 26, Electrical, suitable for performing the control functions required, with the exception of self-contained equipment and where the starters are furnished as part of the control package.

- F. 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.
- G. Control Wiring: All control wiring for plumbing equipment shall be provided herewith.
- H. Codes: All electrical equipment and products shall bear the Underwriters label as required by governing codes and ordinances.

PART 3 EXECUTION

3.01 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.

3.02 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 Above Grade: Similar to interior wall sleeves except caulk outside with Tremco Dymeric Sealant.
- D. Layout work prior to concrete forming. Do all cutting and patching required. Reinforce sleeves to prevent collapse during forming and pouring.
- E. 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.
- F. Do not support pipes by resting pipe clamps on floor sleeves. Supplementary members shall be provided so pipes are floor supported.
- G. Special sleeves detailed on drawings shall take precedence over this section.

3.03 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.

3.04 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.

3.05 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.

3.06 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.

3.07 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.
- D. Exterior Steel: Wire brush and apply two coats of rust-inhibiting primer and one coat of grey exterior machinery enamel.
- E. Exterior Black Steel Pipe: Wire brush and apply two coats of rust-inhibiting primer and one coat of exterior enamel. Painting schemes shall comply with ANSI A13.1.

3.08 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.

3.09 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, natural gas, lab air, sanitary waste and vent, lab 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.

END OF SECTION

SECTION 22 05 23

GENERAL DUTY VALVES AND SPECIALTIES FOR PLUMBING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. The provisions of Section 22 05 00, Common Work Results for Plumbing, apply to work specified in this Section.

1.02 SUMMARY

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

1.03 SUBMITTALS

- A. Submit product data.

1.04 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene copolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- D. NRS: Nonrising stem.
- E. OS&Y: Outside screw and yoke.
- F. RS: Rising stem.
- G. PTFE: Polytetrafluoroethylene plastic.
- H. SWP: Steam working pressure.
- I. Lead Free: Refers to the wetted surface of pipe, fittings, and fixtures in potable water systems that have a weighted average lead content $\leq 0.25\%$ per Safe Drinking Water Act as amended January 4th 2011. Section 1417 *Add specific state requirements as needed.

1.05 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

2.01 ACCEPTABLE MANUFACTURER VALVES

- A. General: Where only NIBCO INC. figure numbers are listed, equivalent products by those specified below are acceptable.
 - 1. Swing Check: Victaulic, Crane, Kennedy, Stockham, Milwaukee, Walworth and Hammond.
 - 2. Silent Check: Mueller, Metraflex, Victaulic, Bell and Gossett, Milwaukee and Gruvlok.

3. Balancing: Bell and Gossett, Armstrong, Tour and Anderson, and Nibco.
 4. Butterfly: Victaulic, Gruvlok, Crane, Walworth, Milwaukee and Metraflex.
 5. 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 22 21 13 for allowable fittings.

2.02 CHECK VALVES

- A. Horizontal Y-Pattern Bronze Swing Check: Bronze body, bronze mounted, regrounding bronze disc, 150 psi steam rating, 300 psi WOG; Nibco 433-Y.
- B. Lead Free Y-Pattern Horizontal Bronze Swing Check: Lead Free Silicon Bronze corrosion resistant body, and trim, PTFE renewable seat and disc, 300 psi CWP; NIBCO S/T 413-Y-LF.
- C. Horizontal Iron Swing Check: Iron body, bronze mounted, renewable seat and disc, 125 psi steam, 200 psi WOG; Nibco 918.
- D. Lead Free Horizontal Iron Swing Check: Iron body, wafer style, renewable seat and disc, 200 CWP psi rating, 200 psi Non-Shock Cold Working Pressure; NIBCO W-910-LF.
- E. Vertical and Silent Check Valves:
1. 250-lb. WOG, iron body, stainless steel spring, wafer type, bronze disc and seat; Nibco 960.
 2. 300-psig CWP, ductile iron body, stainless steel spring and shaft. Victaulic Series 716.
 3. 230-psig CWP, AGS grooved end ductile iron body, stainless steel spring, shaft, and disc, EPDM seat. Victaulic Series W715.
- F. Lead Free Vertical and Silent Check Valves:
1. 250-lb. WOG, iron body, stainless steel spring, wafer type, bronze disc and seat; Nibco W-960.

2.03 BALL VALVES

- A. Bronze Ball: Bronze cast body, chrome-plated full port ball, with handle, Teflon seat, 600 psi WOG, 150 psi steam; Nibco 585-80.
- B. 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.

2.04 BUTTERFLY VALVES

- A. Ductile iron body, nickel chrome plated disc and stainless steel shaft, with lever handle and locking feature on valves 6-inches and less, gear operator on valves 8-inches and over; stem neck length to accommodate insulation where applicable, EPDM liner, 200 psi water; Nibco 2000, Nibco 4765.
- B. Lead Free Butterfly Valve: Ductile iron body, Lead Free Aluminum Bronzedisc and stainless steel stem, with lever handle and locking feature on valves 6-inches and less, gear operator on valves 8-inches and over; stem neck length to accommodate insulation where applicable, EPDM liner, 200 psi water; NIBCO LD- 2000N-3/5,

2.05 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.

2.06 SPECIALTY VALVES

- A. Gas Cock: Forged brass body, hard chromium plated forged brass ball, with handle, rubber seats meeting ASTM D471, 175 psi WOG, entire unit tested to latest version of ANSI Z21.15, AGA and UL listed; Wooster, Parker, Watts, Jamesbury, PGL, ASCO.
- B. Emergency Gas Shutoff: Cast steel, normally closed, manually opened, electrically held open, automatic closing upon power interruption, Maxon Series CMM11. Provide manual gas cock upstream of emergency gas shut-off valve.
- C. Seismic Gas Valve: HL listed, California certified seismic gas and propane earthquake valve, horizontal installation, strand safety equipment.
- D. Gauge Cocks: Brass, tee handle, male to female, 200 psi working pressure, 1/4 inch; Apollo 41 series.
- E. Drain Valves: Bronze globe valve or full port ball valve, garden hose end, cap and chain 3/4 inch size.
- F. Gas Pressure Regulator:
 1. Acceptable Manufacturers:
 - a. Actaris, Maxitrol, Fisher.
 - b. Other Manufacturers: Submit Substitution Request.
 2. Description: 0-500 SCFH capacity at 0-14 inches outlet pressure.
 - a. Body: Cast iron complying with ANSI 125 lb. construction standard.
 - b. Orifice: Aluminum.
 - c. Valve Seat: BUNA-N.
 - d. Diaphragm: BUNA-N.
 - e. Internal relief valve.
 - f. Maxitrol 325 series.
 3. Description: 501-3,000 SCFH capacity at 0-2 PSIG outlet pressure.
 - a. Body: Cast iron complying with ANSI 125 lb. construction standard.
 - b. Orifice: Brass.
 - c. Valve Seat: BUNA-N.
 - d. Diaphragm: BUNA-N.
 - e. Internal relief valve.
 - f. Actaris B38 series.

2.07 WATER PRESSURE REDUCING VALVE ASSEMBLY

- A. Acceptable Manufacturers: Watts No. 223S, similar and equal Fisher, Armstrong Cash Acme.
- B. Description: Bronze body with inlet strainer, water tight cage assembly, 200 psi working pressure and suitable for 200°F.

2.08 SYSTEM SPECIALTIES

- A. Manual Air Vents: Coin type; Dole No. 9 or approved equal.
- B. Pressure/Temperature Test Plug:
 - 1. Acceptable Manufacturers:
 - a. Peterson Engineering, Inc., Universal Lancaster, Sisco, Terrice.
 - 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°F to 125°F for chilled water, 40°F to 240°F for heating water.

2.09 WATER RELIEF VALVES

- A. Acceptable Manufacturers:
 - 1. Consolidated, Kunkle, B&G, Armstrong, Cash Acme.
 - 2. Other Manufacturers: Submit Substitution Request.
- B. Description: Bronze or steel body, stainless steel or bronze, pressure settings to 160 psi at 250°F, conforming to Section IV of ASME Code, size per manufacturer's recommendations based on Code, setting as indicated; Kunkle Model 537.

2.10 STRAINERS

- A. Acceptable Manufacturers:
 - 1. Armstrong, McAlear, Sarco, Steamflo, Mueller, R.P. & C. Company Titan Flow Control.
 - 2. For Grooved Coupling Systems: Gruvlok or Victaulic.
 - 3. Other Manufacturers: Submit Substitution Request.
- B. Wye Pattern:
 - 1. Bronze: Bronze body, 250 psi, 1/16-inch perforated type 304 stainless screen.
 - 2. Ductile Iron: Ductile iron body, 300 psi, 1/16 or 1/8-inch 304 stainless steel screen.
 - 3. Cast Iron: Cast iron body, 125 psi, 1/16-inch perforated type 304 stainless screen.

2.11 EXECUTION

2.12 INSTALLATION

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

- B. Provide separate support for valves where necessary.
- C. Provide drain valves in all low points in the piping system, at coils and equipment, and as indicated.
- D. Coordinate gas pressure regulator selection with inlet pressure available at the regulator and the capacity and outlet pressure required by the equipment served. Install in accordance with manufacturer's recommendations. All gas cocks and gas regulator shall be located to be readily accessible for servicing. Provide approved gas cock immediately upstream of each gas pressure regulator. Provide separate vent to the outside for each regulator.

2.13 APPLIED LOCATIONS PLUMBING VALVES

- A. In piping 2-inches and smaller:

System	Valve Types		
	Swing Check	Ball	Butterfly
Domestic Hot	Lead Free Bronze	Lead Free Bronze	Not Allowed
Domestic Cold	Lead Free Bronze	Lead Free Bronze	Not Allowed
Industrial Cold Water	Bronze	Bronze	Not Allowed
Compressed Air	Bronze	Bronze	Not Allowed

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

System	Valve Types		
	Swing Check	Ball	Butterfly
Domestic Hot	Lead Free Iron	Not Allowed	Lead Free Ductile Iron
Domestic Cold	Lead Free Iron	Not Allowed	Lead Free Ductile Iron
Industrial Cold Water	Iron	Not Allowed	Ductile Iron
Compressed Air	Iron	Not Allowed	Not Allowed

- 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.
- D. Silent check valves on pump discharge for domestic cold water.
- E. Check valves on vertical discharge of sump pumps and sewage ejector pumps, iron swing check with outside weight and lever. Mount in piping at 45 degree angle.
- F. In Natural Gas Piping:
 - 1. Gas cock.
 - 2. Gas pressure regulator.
- G. Provide gauge cock for all pressure gauges.

2.14 VALVE IDENTIFICATION

- A. General: Identify valves to indicate their function and system served.

- B. See Section 22 05 53, Identification for Plumbing Piping and Equipment.

2.15 CHAIN OPERATORS

- A. All valves in equipment rooms or fan rooms used for equipment or coil isolation and more than 8 feet above floor shall be installed with stem horizontal and equipped with chain wheels and chains extending to 6 feet above floor.

2.16 WATER PRESSURE REDUCING VALVE ASSEMBLY

- A. Two valve assembly with smaller valve approximately 33 percent of the total larger valve approximately 66 percent of the total demand. See schedule on drawings for GPM flow rates and pressure settings of valves.

2.17 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. Grooved joints shall be installed in accordance with the manufacturer's published installation instructions. Gaskets shall be molded and produced by the coupling manufacturer, and shall be suitable for the intended service. The coupling manufacturer's factory trained representative shall provide on-site training for the contractor's field personnel in the use of grooving tools and installation of grooved joint products. The representative shall periodically visit the project site to ensure best practices in grooved installation are being followed. (A distributor's representative is not considered qualified to conduct the training of field visits.)
- C. Test Plugs: Install where indicated and in accordance with the manufacturer's recommendations.
- D. Pressure Reducing Valves:
1. Install where indicated and in accordance with manufacturer's recommendations with 3 valve bypass.
- E. Water Relief Valves:
1. Install where indicated, and in accordance with manufacturer's instructions. Pipe discharge to nearest floor drain using Schedule 40 steel pipe.
- F. Strainer:
1. Applied Locations Plumbing:
 - a. Bronze wye, in piping 2-inch and smaller; domestic water, solar hot water, reclaimed water, cold process water, process grey water.
 - b. Cast iron, in piping 2-1/2-inch and larger; solar hot water, reclaimed water, cold process water, process grey water
 - c. Cast iron, high pressure wye, in piping 2-1/2-inch and larger; domestic water.

G. Backwater Valves:

1. Install backwater within vault indicated. If vault not indicated (shallow bury application), provide soil pipe extension to install ferrule and cover at top and flush with floor surface.

END OF SECTION

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SECTION 22 05 29
HANGERS, SUPPORTS AND ANCHORS FOR PLUMBING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. The provisions of Section 22 05 00, Common Work Results for Plumbing apply to work specified in this Section.

1.02 SUMMARY

- A. This Section includes: Supports and anchors for piping systems and equipment.
- B. Related Sections include:
 - 1. Section 22 05 48 Vibration and Seismic Controls for Plumbing Piping and Equipment.
 - 2. Section 22 07 00 Insulation for Plumbing.
 - 3. Section 22 21 13 Pipe and Pipe Fittings Plumbing.

1.03 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

2.01 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.
 - a. Emergency Shelter Requirements:
 - 1) Seismic restraints and anchorages for potable water and waste systems in areas noted to be included as part of the resiliency plan (or emergency shelter) shall be designed to resist seismic forces per category IV requirements of the currently adopted Oregon Structural Specialty Code (OSSC). These areas include:
 - a) Commons 103
 - b) Kitchen 158
 - c) Student Restroom BR101 and GR101 (adjacent to Commons)
 - b. All other systems and areas to be designed per Category III requirements of the currently adopted Oregon Structural Specialty Code (OSSC).

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 22 05 48 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.

2.02 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.

2.03 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.

2.04 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.

2.05 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

3.01 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 22 07 00 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.
4. 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. 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 22 05 48, 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
6-inch	17 feet	14 feet	1/2-inch
8-inch or larger	19 feet	16 feet	5/8-inch

- c. Plumbing Piping: Support in accordance with local plumbing code.
- d. 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

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SECTION 22 05 53

IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. The provisions of Section 22 05 00, Common Work Results for Plumbing apply to work specified in this Section.

1.02 SUMMARY

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

1.03 SUBMITTALS

- A. Submit the following:
 - 1. Valve Tag Directory: Submit for approval prior to fabrication of valve tags.
 - 2. Equipment Nameplate Directory: Submit for approval prior to fabrication.
 - 3. 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

2.01 VALVE IDENTIFICATION

- A. Valve Tags:
 - 1. General: Identify valves with metal tags, legends to be stamped or embossed. It shall indicate the function of the valve and its normal operating position; i.e.,

56 HW	(NUMBER AND CONTENT OF PIPE)
ISOLATION	(VALVE FUNCTION)
NO	(NORMAL OPERATION POSITION)
 - 2. Size: Valve tags 2-inch diameter with 1/4-inch high letters.
 - 3. Material: Use 0.04-inch brass tags.
 - 4. Automatic Valves and Regulating Valves: Use 1/16-inch thick laminated 3-ply plastic, center ply white, outer ply red, "lamicoid". Form letters by exposing center ply.
 - 5. Buildings Systems: Contact the Owner for coordination with existing building tagging system and supplementary information required for any specific system before valve tagging begins.
- B. Valve Tag Directory: Include tag number, location, exposed or concealed, service, valve size, valve manufacturer, valve model number, and normal operating position of valve.

2.02 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
AIR, COMPRESSED	"COMPRESSED AIR"	BLUE
SANITARY WASTE	"SANITARY WASTE"	GREEN
STORM DRAIN	"STORM DRAIN"	GREEN
OVERFLOW DRAIN	"OVERFLOW DRAIN"	GREEN
VENT	"VENT"	GREEN
EMERGENCY EYEWASH & SHOWER	"EMERGENCY SHOWER"	YELLOW
* 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.		

2.03 EQUIPMENT IDENTIFICATION

- A. Nameplates:
1. Tag all pumps, converters, and miscellaneous items of mechanical equipment 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 code number as shown on Drawings and area served.
- B. Equipment Nameplate Directory: List pumps, and other equipment nameplates. Include Owner and Contractor furnished equipment. List nameplate designation, manufacturer's model number, location of equipment, area served or function, disconnect location, and normal position of HOA switch.

2.04 CONCEALED EQUIPMENT IDENTIFICATION

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

B. Adhesive Laminated Tape:

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

PART 3 EXECUTION

3.01 VALVE IDENTIFICATION

A. Valve Tags:

1. Attach to valve with a brass chain.
2. Valve tag numbers shall be continuous throughout the building for each system. Contractor shall obtain a list for each system involved from the Owner.

B. Valve Tag Directory: Post final copy in Operation and Maintenance Manual.

3.02 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.

C. Install tags on specialty gas piping valves with brass chain.

3.03 EQUIPMENT IDENTIFICATION

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

B. Nameplate Directory: Post final copy in Operation and Maintenance Manual.

3.04 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. Trap primers.
2. Shutoff valves.
3. Gas pressure regulators.

4. Emergency gas shutoff valves.

END OF SECTION

SECTION 22 05 90
PRESSURE TESTING FOR PLUMBING SYSTEMS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. The provisions of Section 22 05 00, Common Work Results for Plumbing apply to work specified in this Section.

1.02 SUMMARY

- A. This Section includes: Pressure testing of piping systems.

1.03 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.

1.04 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. The Engineer's representative will record witnessed tests.

PART 2 PRODUCTS – NOT APPLICABLE

PART 3 EXECUTION

3.01 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. Leaks: Repair all leaks and retest until stipulated results are achieved.
- C. Notification: Advise the Construction Manager 72 hours in advance of each test. Failure to so notify will require test to be rescheduled.
- D. Testing Equipment: Provide all necessary pumps, gauges, connections and similar items required to perform the tests.

3.02 TESTING REQUIREMENTS

- A. Sanitary and Roof Drainage Systems: Test entire system or sections of system by closing all openings in piping except highest opening and filling system with water to point of overflow. If system is tested in sections, plug each opening except highest opening of section under test and fill each section with water, but none with less than 10 feet head of water. Keep water in system or in portions under test for at least 45 minutes before inspection starts. Test for two (2) hours with no drop allowed. Locate and repair leaks.
- B. Domestic Water Systems: Test entire system by closing all openings in piping except highest opening and filling system with water to point of overflow. Keep water in system under test for a minimum of 45 minutes before inspection starts. Test at full working pressure for 2 hours with no drop allowed. Locate and repair leaks.

END OF SECTION

SECTION 22 05 93
TESTING, ADJUSTING AND BALANCING FOR PLUMBING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. The provisions of Section 22 05 00, Common Work Results for Plumbing apply to work specified in this Section.

1.02 SUMMARY

- A. This Section includes:
 - 1. Testing and balancing of domestic hot water recirculation systems.
 - 2. Testing and balancing of pumping systems.
- B. Related Sections include:
 - 1. Section 22 08 00 Commissioning for Plumbing.
 - 2. Section 23 09 00 Instrumentation and Controls for HVAC.

1.03 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:
 - a. S1.4 Specifications for sound level meters.
 - b. 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

1.04 SUBMITTALS

- A. Submit the following:
 - 1. Balancing Log: Include all water outlets, actual field measured 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.

1.05 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 equipment has been completely installed and operating continuously as required.
- C. Conduct testing and balancing with clean strainers and filters in place. Clean strainers, etc., prior to performing hydronic testing and balancing.

1.06 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

3.01 DOMESTIC HOT WATER RECIRCULATION SYSTEMS

- A. General: Make measurements in accordance with Industrial Standards specified above. Record on appropriate forms.
- B. Preliminary:
 - 1. List complete data of tested equipment and verify against Contract Documents.
 - 2. Open all line valves to full open position.
 - 3. Set master mixing valve as described by manufacturer's recommendations to achieve desired leaving water temperature.
 - 4. For each pump:
 - a. Verify rotation.
 - b. Test and record pump shut-off head.
 - c. Test and record pump wide-open head.
 - 5. Verify proper system pressures.
- C. Distribution:
 - 1. Read and adjust water flow for design conditions.
 - 2. Set all memory stops and mark position of adjuster on balancing valves.

3.02 DOMESTIC HOT WATER POINT OF USE MIXING VALVES

- A. General: Make measurements in accordance with Industrial Standards specified above. Record on appropriate forms.
- B. Preliminary:
 - 1. List complete data of tested equipment and verify against Contract Documents.
 - 2. Open all line valves to full open position.
- C. Distribution:
 - 1. Adjust water flow for design conditions.
 - 2. Set mixing valve to achieve desired leaving water temperature.
 - 3. Set all memory stops and mark position of adjuster on balancing valves.

3.03 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.

3.04 COORDINATION

- A. Coordinate work with other trades to ensure rapid completion of the project.
- B. Deficiencies noted during the course of 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

SECTION 22 07 00
INSULATION FOR PLUMBING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. The provisions of Section 22 05 00, Common Work Results for Plumbing apply to work specified in this Section.

1.02 SUMMARY

- A. This Section includes: Insulation for piping, and equipment.
- B. Related Sections include:
 - 1. Section 22 05 29 Hangers, Supports and Anchors for Plumbing.

1.03 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.

1.04 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

2.01 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.

2.02 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.
- C. 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.
- D. 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.

2.03 PIPE ACOUSTICAL WRAP

- A. Barrier shall be constructed of a 0.10-inch thick mass loaded, limp vinyl sheet bonded to a layer of reinforced aluminum foil on one side. The barrier shall have a nominal density of 1 lb per square foot and minimum STC rating of 28. The barrier shall have a minimum thermal conductivity value of 0.29 and a rated service temperature range of -40°F to 220°F. Barrier shall have a flame spread index of no more than 10 and a smoke development index of less than 40.
- B. The decoupling layer shall be a combination of 1-inch fiberglass batting, non woven porous scrim-coated glass cloth, quilted together in a matrix of 4-inch diamond stitch pattern which encapsulates the glass fibers. The composite material shall be fabricated to include a nominal 6-inch wide barrier overlap tab extending beyond the quilted fiber glass to facilitate a leak-tight seal around field joints.
- C. Kinectics Noise Control model KNM-100ALQ.

2.04 BLOCK INSULATION

- A. 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.

2.05 ACCESSORIES PIPING

- A. Adhesives:
 - 1. Fiberglass: Zeston Z-Glu.
 - 2. Calcium Silicate: Benjamin Foster 30-36.
 - 3. Elastomeric: Armacell 520.
 - 4. 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. Grooved Coupling Insulation: One piece PVC insulated fitting cover, Zeston, Ceel-Co.
- F. Metal Pipe Jacket: 0.016-inch thick aluminum jacket with formed fitting covers, aluminum snap straps and sealant.
- G. Cloth Facing: Presized fiberglass cloth.
- H. Tapes: Pressure sensitive, weather resistant, and for temperatures up to 150°F. Zeston Z-tape.
- I. Paint: Ultraviolet resistant latex paint with special adherence capabilities to the PVC fitting covers, elastomeric, aluminum facing, Kraft paper, tapes and adhesives.

PART 3 EXECUTION

3.01 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.

3.02 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
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
Interior Storm Drain and Interior Overflow Drains	All	Fiberglass, all purpose jacket	1/2-inch	Note 3
Traps and trap priming lines (In unheated Spaces)	All	Fiberglass, all purpose jacket	1-inch	Insulate over heat tape
Central Compressed Air	All	Elastomeric or Polyolefin	1/2-inch	Note 2
Condensate or other cold water drains	All	Elastomeric or Polyolefin	1/2-inch	Note 2
Storage Tanks	All	Fiberglass, all purpose jacket	3 1/2-inch	
		Elastomeric or Polyolefin	3 1/2-inch	
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 or located above food prep areas.
 - 2. Natural gas.
 - 3. Domestic cold water runouts to single fixture less than 12-inch long and exposed supplies.
 - 4. Priming lines except where heat traced.
- B. Insulation shall include all fittings, unions, flanges, mechanical couplings, valve bodies, valve bonnets, piping through sleeves, except valve bonnets, unions and flanges need not be insulated on the following systems: Domestic and solar hot water, inside building.
- C. 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.

3.04 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. Calcium Silicate Insulation:
 - 1. Secure with 18-gauge wire embedded into insulation.
 - 2. Cover with continuous vapor barrier jacket.
- D. 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.
- E. 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.
- F. 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.
- G. Vapor Barrier Insulation:
1. Refer to Section 22 05 29 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 22 05 29.
- H. Non-Vapor Barrier Insulation:
1. Refer to Section 22 05 29 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.
- I. Acoustical Wrap:
1. Install in accordance with the manufacturer's instructions.
 2. Applied locations for piping systems:
 - a. Where specified or indicated on drawings.

3.05 EQUIPMENT INSTALLATION

- A. General: Install true and smooth. Insulation over curved surfaces shall conform to curves of surface.
1. Access: Insulated removable heads, water boxes, pump casings, access, etc., that require service, inspection or maintenance shall be provided with covers or section that are easily removable and replaceable. Reinforce openings in adjacent insulation with metal beading. In vapor barriered insulation, coat joints with vapor barrier mastic.
 2. Voids, Depressions and Cavities: All voids, chipped corners and other openings shall be filled with insulating cement or material compatible with insulating material.
 3. Vapor Barriered Insulation: Where insulation is specified to have a vapor barrier, the barrier shall not be pierced or broken.
 - a. Tears, etc., shall be coated with vapor barrier mastic and patched with insulation facing or tape.
 - b. Staples brush coated with vapor barrier coating.
 - c. All raw edges coated with vapor barrier mastic shall be covered and cover shall be sealed to equipment surface.
 4. Non-Vapor Barriered Insulation:
 - a. Tears, etc., shall be patched with insulation facing or tape.
 - b. All raw edges shall be covered and neatly beveled to the equipment surface.
 5. Multilayered Insulation: With staggered joints.
- B. Fiberglass Block:
1. Anchors: Lug nuts 10 gauge black annealed iron wire welded to metal surfaces.
 2. Banding: Block secured to surface with 1/2-inch wide stainless steel bands maximum 18-inches on center and secured to anchors.
 3. Insulating Cement: Block covered with insulating cement minimum thickness of 1/2-inch with smooth finish.
 4. Vapor Barriered System: On vapor barriered system, apply continuous coat of vapor barrier mastic.

- 5. Finish: Finish with cloth facing secured with adhesive and lapped a minimum of 2 inches. Defects touched up with finishing cement.
- C. Elastomeric Blanket: Cut insulation to size, make corners with mitering cuts to preclude raw edges, continuously cement insulation to equipment with adhesive. Cement both surfaces of joints and butt tightly together and cover raw edges with two coats of adhesive.

3.06 FIELD QUALITY CONTROL

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

END OF SECTION

SECTION 22 21 13
PIPE AND PIPE FITTINGS PLUMBING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. The provisions of Section 22 05 00, Common Work Results for Plumbing apply to work specified in this Section.

1.02 SUMMARY

- A. This Section includes: Furnish piping, pipe fittings, and incidental related items as required for complete piping systems.
- B. Related Sections Include:
 - 1. Section 22 25 00 Plumbing Water Treatment.

1.03 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. All grooved joint couplings and fittings shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.
 - 1. All castings used for coupling housings, fittings, valve bodies, etc., shall be date stamped for quality assurance and traceability.
- C. 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.
- D. Correct any damage to the building or systems resulting from failure to properly clean the system without additional expense to the Owner.
- E. 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.

1.04 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. Product data on mechanical couplings and related components, double wall fuel oil pipe and fittings, and polypropylene waste and vent pipe.
- B. Test Reports and Certificates: Submit certificates of inspections and pipe tests to Owner.
- C. Other: Make certified welders' certificates available.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. As indicated.

2.02 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. Buried: Husky 28 gauge 304 stainless steel hubless type clamp and orange corrugated shield assemblies (80-inch pound torque) with neoprene sealing gaskets (ASTM-C-564), or Clamp-All (125-inch pound torque), 24 gauge 304 stainless steel hubless type clamp, and shield assemblies with neoprene sealing gaskets (ASTM-C-564).
 - 3. Service:
 - a. Above grade sanitary, storm, and overflow drain.
 - b. Above grade vent piping 2 inches and above.

2.03 BLACK STEEL PIPE, SCHEDULE 40

- A. General: Fittings and joints must be UL listed for use with pipe chosen for use. Listing restrictions and installation procedures per state and local authorities must be followed.
- B. Pipe: Schedule 40 conforming to ASTM A 135 or A 53.
- C. Fittings: 150 lb. screwed malleable iron on 2 inches and below, Schedule 40 welding fittings conforming to ASTM A 234 for 2-1/2 inches and above or mechanical couplings on select piping as herein specified. Fittings below grade shall be welding fittings. All elbows on pumped systems shall be long radius type. Short radius elbows not acceptable for use except as approved on a case by case basis.
- D. Service:
 - 1. Compressed air piping.
 - 2. Natural gas piping and vent lines.

2.04 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. 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 above ground (Type L, hard drawn) on piping 4 inches and smaller.
2. Industrial cold water above grade (Type L) on piping 4-inch and smaller.
3. Pumped waste (DWV).
4. compressed air.
5. Miscellaneous drains and overflows.

2.05 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, 1/8-inch thick, non-metallic type. Gaskets for steam and pumped condensate shall be Flexitauclic Style CG, 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.

2.06 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.)

2.07 MECHANICAL PIPE COUPLINGS AND FITTINGS

- A. Acceptable Manufacturers:
1. Victaulic.
 2. Anvil Gruvlok 7401, 7001.
 3. Other Manufacturers: Submit Substitution Request.
- B. Coupling: Ductile iron conforming to ASTM A 536, Grade 65-45-12, rust inhibiting paint.
- C. Fittings: Ductile iron conforming to ASTM A 536, Grade 65-45-12. Elbows shall be long radius type.
- D. Bolts and Nuts: Zinc electroplated track head bolts conforming to ASTM A 183.
- E. Gasket: Grade "E" EPDM.
1. Temperature Range: -30°F to 230°F.
- F. Service: Compressed air mains.

2.08 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, and pumped waste.
 - c. Lab air. Braze in accordance with Copper Development Association Copper Tube Handbook using BCUP series filler material.
 - d. 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, pumped waste.

2.09 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

3.01 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.

3.02 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. Mechanical Pipe Couplings and Fittings:

1. Flexible couplings to be used only when expansion, contraction, deflection or noise and vibration is to be dampened, as detailed or specified.
2. On systems using galvanized pipe and fittings, fittings shall be galvanized at factory.
3. Before assembly of couplings, lightly coat pipe ends and outside of gaskets with approved lubricant.
4. Gaskets shall be molded and produced by the coupling manufacturer, and shall be suitable for the intended service.
5. The coupling manufacturer's factory trained representative shall provide on-site training for the contractor's field personnel in the use of grooving tools and installation of grooved joint products. The representative shall periodically visit the project site to ensure best practices in grooved installation are being followed. (A distributor's representative is not considered qualified to conduct the training or field visits.)

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

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

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

F. Dielectric Fittings: Minimum of 6-inch long, brass fitting shall be used between dissimilar metals. Use of dielectric fittings is not acceptable in domestic water systems, with the following exceptions:

1. Use 3/4-inch dielectric copper flex connector for water heater connections.

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

H. PIPING JOINTS

I. 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.

J. 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.

K. No couplings installed in floor or wall sleeves.

L. 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.

M. Welded Joints:

1. Preparation for Welding: Bevel piping on both ends before welding:

- a. Use following weld spacing on all butt welds:

Nominal Pipe Wall Thickness	Spacing	Bevel
1/4-inch or less	1/8-inch	37-1/2
Over 1/4-inch, less than 3/4-inch	3/16-inch	27-1/2

- b. Before welding, remove all corrosion products and foreign material from surfaces.
2. Welded Joints: Joints shall be made by the "arc-welding" process using certified welders. Port openings of fittings must match the inside diameter of the pipe to which they are welded. Use full radius welding elbows for all turns, use welding tees for all tees. Reducing fittings must be used for size reduction. "Weldolets" may be used for branches up through one-half the pipe size of the main to which they are attached. Nipples are not allowed.
3. Welding Operation:
 - a. After deposition, clean each layer of weld metal to remove slag and scale by wire brushing or grinding. Chip where necessary to prepare for proper deposition of next layer.
 - b. Weld reinforcement no less than 1/16-inch not more than 1/8-inch above normal surface of jointed sections. Reinforcement crowned at center and taper on each side to surfaces being joined. Exposed surface of weld shall present professional appearance and be free of depressions below surface of jointed members.
 - c. No welding shall be done when temperature of base metal is lower than 0°F. Material to be welded during freezing temperatures shall be made warm and dry before welding is started. Metal shall be "warm to the hand" or approximately 60°F.

- N. Flexible Connector: Provide where indicated on the Drawings.

O. Above Grade No-Hub Couplings:

1. Install in accordance with manufacturer recommendations.

3.03 INSTALLATION, PIPE WRAP

- A. Apply per manufacturer's written instructions.
- B. Apply wrapping to fittings in field after installation.

3.04 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 22 25 00 "Plumbing Water Treatment" prior to being placed in service.

4. Clean all strainers prior to placing in service.

3.05 INSTALLATION, NATURAL GAS PIPING

- A. Install piping where shown on Drawings.
- B. Black Steel Pipe:
 1. Welded joints shall be made by the "arc-welding" process by certified welders as outlined above.
 2. On piping below grade install protective pipe wrap after testing and prior to backfilling in accordance with the manufacturer's recommendations. Overlap one-half spiral lap for double thickness.
 3. Piping installed under building floor slabs in vented sleeve per code.

END OF SECTION

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SECTION 22 40 00
PLUMBING FIXTURES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. The provisions of Section 22 05 00, Common Work Results for Plumbing apply to work specified in this Section.

1.02 SUMMARY

- A. This Section includes:
 - 1. Plumbing fixtures.
 - 2. Fixture trim.
 - 3. Drainage products.
 - 4. Miscellaneous plumbing items.

1.03 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. Electric Water Coolers and Drinking Fountains shall be certified to NSF/ANSI 61 and California AB1953.
- D. Emergency Eyewash and Emergency Shower Equipment shall comply with ANSI standard Z358.1.

1.04 SUBMITTALS

- A. Submit the following:
 - 1. Product data for each item specified.
 - 2. Operating and Maintenance Data:
 - a. Electric water coolers.
 - 3. Mounting heights for all fixtures.

PART 2 PRODUCTS

2.01 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. Vitreous China Water Closets and Urinals: American Standard, Kohler.
- D. Vitreous China Sinks & Lavatories: Kohler only.
- E. Seats: Olsonite, Church, Beneke, Bemis.

- F. Electric Water Coolers: Elkay only.
- G. Drinking Fountains: Elkay only.
- H. Mixing Valves: Powers, Leonard, Symmons, Chicago.
- I. Emergency Fixtures: Haws. only
- J. Emergency Fixture Mixing Valves: Leonard, Bradley, Lawler.
- K. Stainless Steel Products: Bradley, Elkay.
- L. Shower/tub Controls: Chicago only.
- M. Water Filter: Aqua pure only.
- N. Mop Sinks: Fiat, Williams, Mustee.
- O. Faucets: Chicago only.
- P. Metering Faucets: Chicago only.
- Q. Flush Valves: Sloan only.
- R. Shock Arrestors: PPP, J.R. Smith.
- S. Trap Primer Stations: PPP only.
- T. Exposed Waste and Supply Piping Insulation Kits: Truebro, McGuire.
- U. Other Manufacturers: Submit Substitution Request.

2.02 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.

2.03 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.
 - 2. Sloan Royal manual flush valve with dual filtered fixed bypass diaphragm. (1.28 GPF).
 - 3. 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.
 - 4. J.R. Smith Series 200 chair carrier.
- B. WC-2 Water Closet (ADA): Same at WC-1, except mounted at ADA mounting height.

C. L-1 Lavatory (Commerical - ADA):

1. American Standard Lucerne 20-1/2-inch by 18-1/4-inch, vitreous china, self-draining deck, backsplash, 4-inch centers, wall hung, concealed arm support, grid drain, white color finish.
2. Chicago 802 series hot and cold water metering faucet with polished chrome plated solid brass body construction, 4-inch fixed centers, temperature selection, time limit stop, 1/2 GPM non-aerating spray, vandal resistant, complete with cast iron wall bracket.

D. S-1 Hand Wash:

1. Bradley stainless steel washfountain, 54" four person semi-circular, 9" deep bowl with infrared activation.

E. MS-1 Mop Sink:

1. Regency 16-gauge stainless steel one compartment sink, 20 x 16 x 6 inch, wall bracket, 5-foot hose, bumper guards & wall guards (back side).
2. Chicago 445 series wall mounted service faucet with polished chrome plated solid brass body construction, lever handles, pail hook, wall brace, vacuum breaker, check stops and hose thread outlet.

F. DF-1 Drinking Fountain (ADA): Elkay EHW17C, heavy duty 14 gauge, type 304 stainless steel dual height drinking fountain.

1. Surface mounted fountain.
2. Contoured basins.
3. Push pad operated bubblers.
4. Vandal resistant bubbler guards.
5. Surface mounting plate.

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

H. 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. Mixing valve shall meet ASSE 1070/CSA B125.3.

2.04 EMERGENCY FIXTURES

A. EEW-1 Emergency Eyewash: Haws 7260BT-7270BT series wall mount eye/facewash, anti-surge heads, push pad stay open valve.

B. EMV-1 Emergency Fixture Mixing Valve Assembly:

1. Leonard TA-300 series exposed mixing valve assembly consisting of but not limited to:
 - a. Bronze body
 - b. Rough finish
 - c. Bimetal thermostat element directly linked to inlet porting - compensating for supply temperature and pressure fluctuations, adjustable high temperature limit stop - factory set at 90 degrees F locking temperature regulator - factory set at 85 degrees F

- d. Angle check stops
 - e. Outlet dial thermometer
 - f. Wall mounting bracket.
2. Mixing valve must have built-in cold water bypass with the capacity of delivering 1.25 GPM or more cold water upon failure of hot water supply.

2.05 DRAINAGE PRODUCTS –

- A. HB-1 Hose Bibb: Chicago 952 series, chrome-plated, removable key, 3/4-inch hose thread, integral vacuum breaker.
- B. WH-1 Wall Hydrant: J.R. Smith 5509 series, bronze finish, removable key, 3/4-inch hose connection, integral vacuum breaker, freeze proof, in locking stainless steel recessed box.
- C. 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.
- D. WCO Wall Cleanout: J.R. Smith 4530 series, round stainless steel vandal resistant cover and screw.
- E. FCO Floor Cleanout: J.R. Smith 4020 series, round vandal resistant, nickel bronze top.
- F. Water Hammer Arrester: Precision Plumbing Products Model SC (Maintenance-Free).

PART 3 EXECUTION

3.01 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.

3.02 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.
5. Urinals:
 - a. Mounting height of ADA water closet shall be at a maximum height of 17 inches from floor to rim.
- B. Fixture Mounting Heights: All fixtures standard rough-in catalogued heights unless shown otherwise on the Architectural Drawings.
- C. Showers:
 1. Piping from shower mixing valve to shower head shall be rigid pipe. PEX piping not allowed.
 2. Shower Head Mounting Heights: Mount so that face of head is at 6'-6" above finished floor and shall not conflict with shower enclosure.
- D. 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.
- E. 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. Coordinate installation at CMU walls with manufacturers installation requirements and provide carriers with necessary components for complete installation.
- F. Lavatories:
 1. Public toilet room lavatories shall have grid strainers.
 2. Private toilet room lavatories (dorms, apartments, condos, etc.) shall have pop-up waste assemblies.
 3. 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.
- G. Floor Drain and Floor Sinks:
 1. Set top flush with finished floor.
 2. Provide flashing clamp for all drain bodies installed in floors provided with waterproof membranes.
- H. Cleanout:
 1. Where shown or required.
 2. Cover set flush with finished surface.
- I. Roof and Area Drains: Provide sump receivers for all drains except poured in place installations. Provide extension section as required to compensate for the specified insulation thickness above the roof slab or deck.
- J. Water Hammer Arresters: Provide where shown and where recommended by Plumbing Drainage Institute (PDI).
- K. Water Coolers and Drinking Fountains:
 1. All water-bearing materials shall comply with the Safe Drinking Water Act of 1986 and the Lead Contamination Control Act of 1988. The waterway system of the unit shall be manufactured of copper components and other completely lead-free materials.

2. All water cooler refrigerants will be non-CFC.
 3. Provide fixture manufacturer's wall mounting plate or floor mounted support for all wall-hung water coolers or drinking fountains.
- L. Mixing Valves: Provide piping connections per manufacturer's installation instructions.
- M. Water closets equipped with a dual flush devices shall be marked with the reduced flush volume and the designation ASME A112.19.14 to signify compliance with the standard.

3.03 PRIMING VALVES

- A. All floor drains, floor sinks 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.
- C. Coordinate locations of electronic trap primer stations with electrical contractor for 120V service.

3.04 KITCHEN EQUIPMENT

- A. General: Kitchen equipment is supplied and set in place by Kitchen Supplier. Obtain drawings before any rough-in is started. Complete installation and furnish all equipment required or scheduled below to give complete working installation. Symbol numbers are indicated by (_____) symbol with number inside. See "PLUMBING FIXTURES" for supply types and traps.

END OF SECTION

SECTION 23 05 00
COMMON WORK RESULTS FOR HVAC

PART 1 GENERAL

1.01 SUMMARY

- A. The intent of Division 23, HVAC 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 work specified in Division 23, HVAC and shown on the accompanying Drawings, including appurtenances, connections, etc., in the finished job.
- B. Division 23, HVAC Specifications are intended to provide requirements as they relate to new equipment and products required to reconfigure and refurbish existing systems as described in the contract documents.
- C. The Drawings that accompany the Division 23, HVAC 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 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.
- D. 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.
- E. Division 01, General Requirements, General Requirements, applies to this Division.

1.02 RELATED SECTIONS

- A. Division 01, General Requirements
- B. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)

1.03 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Products and equipment 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: Work and materials conforms to the local and State codes, and Federal, State and other applicable laws and regulations.
 - 3. Contractor responsible for obtaining and payment for permits, licenses, and inspection certificates required in accordance with provisions of Contract Documents.

- B. New materials and equipment. Work of good quality, free of faults and defects and in conformance with the Contract Documents.
- C. Apparatus built and installed to deliver its full rated capacity at the efficiency for which it was designed.
- D. The entire mechanical system and apparatus operates at full capacity without objectionable noise or vibration.
- E. Install equipment level and true. Housekeeping pads and curbs account for floor or roof slope.
- F. Materials and Equipment:
 - 1. Each piece of equipment furnished meet detailed requirements of the Drawings and Specifications and suitable for the installation shown. Equipment not meeting 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 materials and equipment of size, make, type, and quality herein specified.
 - 4. Equipment scheduled by performance or model number 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 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: Install materials in a neat and professional manner.
 - 2. Manufacturer's Instructions:
 - a. Follow manufacturer's directions where they cover points not specifically indicated.
 - b. If conflict with the Drawings and Division 23, HVAC 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 performed by skilled craftsmen of each respective trade in conformance with the appropriate Division of Work.
 - 2. Additional openings required in building construction 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. Do not pierce beams or columns without permission of Architect and then only as directed.

5. Restore new or existing work cut or damaged to its original condition. Where alterations disturb lawns, paving, walks, etc., surfaces repaired, refinished, and left in condition existing prior to commencement of work.

1.04 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 piping, ductwork, and equipment installations. Shop Drawings 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. Drawings the same size as Architect's Drawings with title block similar to Contract Drawings and identifying Architect's Drawing number or any reference drawings. Drawings fully dimensioned including both plan and elevation dimensions. Shop drawings cannot be used to make scope changes.
2. Prepare in two-dimensional format.
3. 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-foot scale.
 - b. Sheet metal and HVAC piping of mechanical and fan rooms to a minimum of 1/2-inch equals 1-foot scale.
 - c. Sections of congested areas to a minimum of 1/2-inch equals 1-foot scale.
 - d. Beam penetration drawings indicating beam penetrations meeting the requirements indicated on the floor plans and on the structural drawings to a minimum of 1/4-inch equals 1-foot scale.
 - e. Slab penetration drawings of HVAC, plumbing, sprinklers, lighting and electrical to a minimum of 1/4-inch equals 1-foot scale.
 - f. Fabrication drawings of radiant ceiling panels, architectural metal ceiling, including panel penetrations for lighting, sprinkler heads, fire alarm devices, and any other penetrations.
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 scheduled pieces of equipment, on 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 include capacities, RPM, BHP, pressure drop, design and operating pressures, temperatures, and similar data. Manufacturer's abbreviations or codes are not acceptable.

2. 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 01, General Requirements for additional requirements related to submittals.
 - b. Submit electronic copies of shop drawings and product data for Work of Division 23, HVAC 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. Partial submittals will not be accepted. Other stragglers submitted after return of the original binder includes a tab similar to that originally submitted. Upon receipt of the returned late submittal, insert them in the previously submitted binder.
- D. Contractor Responsibilities:
 1. Submit submittals one time and are in proper order.
 2. Ensure that equipment will fit in the space provided.
 3. Assure that deviations from Drawings and Specifications are specifically noted in the submittals. Failure to comply will void review automatically.

1.05 AS-BUILT DRAWINGS

- A. Provide record drawings at the end of the project on CD-ROM.
- B. Record drawings in the following source format:
 1. AutoCAD
- C. Record Drawings: Provide hard copies and pdf format.
 1. Drawings include the following:
 - a. Project Specific Titleblock.
 - b. Notations reflecting the as built conditions of any additions to or variations from the construction documents provided as part of the BIM coordination, RFIs, ASIs, Owner Changes, and Field Coordination.

1.06 OPERATING AND MAINTENANCE MANUAL, PARTS LISTS, AND OWNER'S INSTRUCTIONS

- A. Refer to Division 01, General Requirements 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 on 8-1/2-inch by 11-inch 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 electrically powered equipment.
- C. Instruct Owner thoroughly in proper operation of equipment and systems, in accordance with manufacturer's instruction manuals. Operating instructions cover phases of control.

1.07 PROJECT CONDITIONS

- A. Existing Conditions:
 - 1. Prior to bidding, verify and become familiar with existing conditions by visiting the site, and include factors which may affect the execution of this Work.
 - 2. Include related costs in the initial bid proposal.
- B. Coordinate exact requirements governed by actual job conditions. Check information and report 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, the City, and Utility Company.

1.08 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.

1.09 TEST REPORTS AND CERTIFICATES

- A. Submit one copy of test reports and certificates specified herein to the Architect.

1.10 SUBSTITUTIONS

- A. Submit requests for product substitutions in accordance with the Instructions to Bidders and the General and Supplemental Conditions.

PART 2 PRODUCTS

2.01 ACCESS PANELS

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

2.02 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. 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.

2.03 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.

2.04 MACHINERY GUARDS

- A. Furnish guards for protection on rotating and moving parts of equipment. Provide guards for metal fan drives and motor pulleys, regardless of being enclosed in a metal cabinet.
- B. Design guards so as not to restrict air flow at fan inlets resulting in reduced capacity.
- C. Provide shaft holes in guards for easy use of tachometers at pulley centers. Guards easily removable for pulley adjustment or removal and changing of belts.
- D. Guards meet OSHA requirements including back plates.
- E. Provide inlet and outlet screens on fans in plenums or where exposed to personnel.

PART 3 EXECUTION

3.01 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 UL label.
- C. Furnish 18-inch by 18-inch panels for ceilings and for access to equipment in soffits and shafts, and 12-inch by 12-inch for walls unless indicated otherwise.
- D. Furnish where indicated and where required to access valves, fire/smoke dampers, trap primers, shock arresters, and other appurtenances requiring operation, service or maintenance. Submit proposed locations for review prior to installation.

3.02 SLEEVES

- A. Interior Floor and Wall Sleeves:
 - 1. Provide sleeves large enough to provide 3/4-inch clearances around pipe or ductwork.
 - 2. Where pipe or ductwork is insulated, insulation passes continuously through sleeve with 3/4-inch clearance between insulation and sleeve.
 - 3. Penetrations through mechanical room and fan room floors 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 or duct material, size and service.
- C. Sleeves specified or indicated at fire damper penetrations take precedence over this article.
- D. Exterior Wall Sleeves Below Grade:
 - 1. Provide water tight sleeves. Install at pipes entering building below grade and where shown.
 - 2. Adjust to provide positive hydrostatic seal.
 - 3. Follow manufacturer's procedure for installing and tightening seal.
 - 4. Secure sleeves against displacement.
- E. On Grade Floor Sleeves: Same as below grade exterior wall sleeves, caulked from inside.
- F. Exterior Wall Sleeves Above Grade: Similar to interior wall sleeves except caulk outside with Tremco Dymeric Sealant.
- G. Layout work prior to concrete forming. Do cutting and patching required. Reinforce sleeves to prevent collapse during forming and pouring.
- H. Floor sleeves maintain a water barrier by providing a water tight seal or they extend 1-inch above finished floor except through mechanical equipment room floors and shafts where sleeves extend 2-inches above finished floor level. Sleeves through roof extend 8-inches above roof. Wall sleeves flush with face of wall unless otherwise indicated.
- I. Do not support pipes by resting pipe clamps on floor sleeves. Supplementary members provided so pipes are floor supported.
- J. Special sleeves detailed on drawings take precedence over this section.

3.03 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.

3.04 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.

3.05 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.

3.06 FLOOR, WALL, AND CEILING PLATES

- A. Install on piping and ductwork passing through finished walls, floors, ceilings, partitions, and plaster furrings. Plates completely cover opening around pipe and duct.
- B. Secure wall and ceiling plates to pipe, insulation, or structure.
- C. Plates not penetrate insulation vapor barriers.
- D. Plates not required in mechanical rooms or unfinished spaces.

3.07 PAINTING

- A. General:
 - 1. Coordinate painting of mechanical equipment and items with products and methods in conformance with the appropriate Division of Work, Painting.
 - 2. Exposed work under this Division receives either a factory painted finish or a field prime coat finish, except:
 - a. Exposed copper piping.
 - b. 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:
 - a. One coat of grey machinery enamel.
 - b. Do not paint nameplates.
 - 6. 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. Do not paint the following:
 - a. Hangers
 - b. Uninsulated Piping
 - c. Miscellaneous Iron Work

d. Valve Bodies and Bonnets

- D. Exterior Steel: Wire brush and apply two coats of rust-inhibiting primer and one coat of grey exterior machinery enamel.
- E. Roof Mounted Equipment:
 - 1. Paint two coats of exterior machinery enamel.
 - 2. Color as selected by Architect.
 - 3. Where factory standard finish is indicated in the equipment specification, it is assumed that the standard finish is painted.
- F. Exterior Black Steel Pipe:
 - 1. Wire brush and apply two coats of rust-inhibiting primer and one coat of exterior enamel.
 - 2. Painting schemes comply with ANSI A13.1.

3.08 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.

3.09 EQUIPMENT CONNECTIONS

- A. Make final connections to equipment specified in sections other than Division 23, HVAC of the specifications and Owner furnished equipment in accordance with manufacturer's instructions and shop drawings furnished and as indicated.
- B. Piping:
 - 1. Connections include steam supply, steam vent, and condensate.
 - 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. Independently support piping connections supported to prevent undue strain on equipment.

END OF SECTION

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SECTION 23 05 14
VARIABLE FREQUENCY DRIVES FOR HVAC EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

- A. This Section includes:
 - 1. Variable Frequency Drives

1.02 RELATED SECTIONS

- A. Division 01, General Requirements
- B. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)
- C. Section 23 09 00, Instrumentation and Controls for HVAC

1.03 SUBMITTALS

- A. Submit the following:
 - 1. Product data on variable frequency drives and related components.
 - 2. Startup log/check list showing successful operation.
 - 3. Operation and maintenance data.

1.04 WARRANTIES

- A. Provide 24-month warranty from date of shipment to include full replacement covering parts and labor.

PART 2 PRODUCTS

2.01 VARIABLE FREQUENCY DRIVES

- A. Manufacturers:
 - 1. ABB
 - 2. Other Manufacturers: Submit substitution request.
- B. General Description:
 - 1. Variable Frequency AC Motor Drive (VFD):
 - a. Pulse width modulated (PWM) inverter type.
 - b. Designed to convert 60 Hz input power to adjustable frequency output power to provide positive speed control to standard induction motors.
 - c. Dedicated variable torque design for specific use with centrifugal loads.
 - 2. Provide completely solid state variable frequency power and logic unit.
 - 3. Speed control to be stepless throughout the range under variable torque load on continuous basis. Speed controlled by remote building energy management system providing 4-20MA, 0-10V, or 2-10V input signal to drive and remote start/stop signal. Coordinate with Section 23 09 00, Instrumentation.

4. Provide adjustable frequency control with diode bridge/capacity input designed to provide high, constant power factor of 0.95 regardless of load or speed and eliminate SCR line noise.
 5. Equipment will be designed and manufactured in accordance with applicable current NEMA and IEEE recommendations and be designed for installation per NEC. Equipment will be UL listed and bear the UL label.
 6. Control suitable for operation in ambient temperatures of 32 degrees F to 104 degrees F.
 7. Factory tested with an AC induction motor 100 percent loaded and temperature cycled within an environmental chamber at 104 degrees F.
- C. Self-Protection and Reliability Features:
1. Adjustable current limit to 60 percent to 110 percent of drive rating.
 2. Adjustable instantaneous overcurrent trip.
 3. Under voltage trip.
 4. Over temperature trip.
 5. Short circuit protection phase to phase and phase to ground faults phase rotation insensitive.
 6. Momentary power loss, more than 17 milliseconds.
 7. Transient protection against normal transients and surges in incoming power line.
 8. Orderly shutdown in event of any of above conditions, drive designed to shut down safely without component failure.
 9. Provide visual indication and manual reset.
- D. Standard Features:
1. Drive Logic: Microprocessor based
 2. Control Logic: Isolated from power circuitry.
 3. Standalone operation to facilitate start up and troubleshooting procedures.
 4. UL 508C listed for drives serving a single motor or UL 508A listed for drives serving multiple motors, for use on distribution systems with 22,000 AIC.
 5. Output voltages equal to applied input voltage.
 6. Isolated signal inputs.
 7. Frequency Stability. Output frequency will be held to +0.1 percent of maximum frequency regardless of load, +10 percent input voltage change or temperature changes within ambient specification.
 8. Built-in digital display indicates output frequency, voltage, and current and provide indication of over current, over voltage, current limit, ground fault, over temperature, input power on, minimum or maximum speed adjustment, power on, fault condition. Display on panel face.
 9. Start/Stop Control - Controlled decelerated stop.
 10. Primary and secondary fused for a control circuit transformer.

11. Minimum and maximum speed control.
12. Adjustable Accel/Decel - independently adjustable 10-100 second.
13. Hand-Off auto switches.
14. Programmable Auto Restart - after power outage.
15. Provide fused disconnect, including auxiliary contacts to isolate control circuit when disconnect is in "off" position, except fused disconnects not required where packaged equipment is provided with a single point connection with single point disconnect and internal overcurrent protection for VFD and motors.
16. Remote contacts for fault, and on/off status.
17. Adjustable motor output voltage.
18. Analog output voltage of 0-10 VDC, -20 MA proportional to control output frequency.
19. Provide a NEMA 1 enclosure for indoor applications and NEMA 3R enclosure for outdoor applications to isolate each motor starter and control section with its associated disconnect switch.
20. Manual speed control for each motor.
21. Provide RF, and EMI, noise suppression network to limit RF and EM interference.
22. Provide isolated analog output signals for volts, amps, and frequency, from each VFD for connection to the building energy management system.
23. Provide line (input) reactors.
24. Provide output filters for VFD's located more than 25 conductor feet from the motor they serve. Output reactors permit VFD's to be located up to 350-feet from the motors they serve.
25. Design VFD to catch spinning load in forward and reverse direction.
26. Harmonic Calculations: Perform on manufacturer supplied Harmonic Analysis program to provide conformance with IEEE 519-1992.

E. Communications:

1. Provide factory installed communication chip for direct network connection to DDC Control System specified in Section 23 09 00, Instrumentation and Controls for HVAC. Interface allows for control and interface functions specified herein and in Section 23 09 00, Instrumentation and Controls for HVAC. Interface control functions and information includes, but not be limited to the following:
 - a. Start/Stop
 - b. Change Directions
 - c. Drive Fault
 - d. Drive Fault Codes
 - e. Reset Drive
 - f. Percent Output
 - g. Speed

- h. Power
 - i. Drive Temp
 - j. KWH
 - k. Run Time
- 2. Provide isolated analog output signals for volts, amps and frequency from each VFD for connection to the DDC Control System specified in Section 23 09 00, Instrumentation and Controls for HVAC.
- 3. Provide RS485 communications port and programming software capability.
- F. Drives for smoke control systems:
 - 1. The drive must be protected in an environment that meets manufacturer recommendation.
 - 2. Do not permit the motor to run into the service factor of the motor.
 - 3. Settings for drive operation and proper speed control cannot be stored in volatile memory subject to loss in a power loss.
 - 4. Smoke detection system must meet UL 864 standard, UL 508.
 - 5. The VFD must be capable of operation from a contact closure from an alarm panel. When override/alarm panel is active:
 - a. Drive operates at a preset speed.
 - b. Drive ignores keypad commands to include Auto, OFF, or Hand Mode or even removal of keypad panel.
 - c. Drive ignores commands from communication links.
 - d. Drive ignores digital inputs except override activation/deactivation, Run Enable and Start Enable.
 - e. Drive displays message indicating it is operating in override operation.
 - f. No safeties are to be wired to the VFD. The VFD is only used for smoke and purge control. The VFD is to ignore faults when operating in Override Mode.

PART 3 EXECUTION

3.01 VARIABLE FREQUENCY DRIVE INSTALLATION

- A. Install VFD in accordance with manufacturer's written installation instructions.
- B. Install on strut support stand.
- C. Provide one drive for each motor as scheduled.

3.02 START UP

- A. General: Comply with manufacturer's instructions for startup.
- B. Provide under direct supervision of the manufacturer's representative with factory trained personnel.

3.03 FIELD QUALITY CONTROL

- A. Prior to installation, manufacturer's representative coordinate variable speed drive control interface with the controls contractor and verify that intended installation (controls, wiring, etc.) complies with the manufacturer's recommendations.
- B. Field Test: Except where initial variable speed drive operation clearly shows the performance meets or exceeds the requirements, test to show compliance. Tests performed by the manufacturer's representative in the presence of the Engineer.

END OF SECTION

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SECTION 23 05 18
HVAC EXPANSION COMPENSATION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01, General Requirements Specification Sections, apply to this Section.
- B. The provisions of Division 23, Heating, Ventilation and Air Conditioning (HVAC) Section 23 05 00, Common Work Results for HVAC, apply to work specified in this Section.
- C. The provisions of this specification are intended to provide requirements as they relate to new equipment and products required to reconfigure and refurbish existing systems as described in the contract documents.

1.02 SUMMARY

- A. This Section includes Design-Build work.
- B. This Section includes:
 - 1. Expansion Joints and Compensators
 - 2. Expansion Loops/Seismic Expansion Joints

1.03 RELATED SECTIONS

- A. Division 01, General Requirements
- B. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)
- C. Section 23 05 29, Hangers, Supports and Anchors for HVAC

1.04 QUALITY ASSURANCE

- A. Design expansion joints, pipe guides, and related supports, braces, and anchorages to building structure to absorb thermal expansion and contraction of piping and terminal movement, as well as to resist the static and dynamic loads due to fluid flow at design conditions, hydraulic testing pressures, and seismic forces.
- B. Expansion Joints, Guides, and Related Supports, Braces, and Anchorage to Building Structure: Provide design and details bearing the seal of a professional engineer registered in the State having jurisdiction.
- C. Use expansion joints in straight lengths of rigid pipe anchored and guided in accordance with best practices recommendations of ASHRAE and ASME B31.9.
- D. Avoid use of expansion joints in conjunction with U-bends or other piping systems with inherent flexibility, such as piping with flexible mechanical couplings. If expansion joints are used in piping with bends, thorough analysis of pipe stresses and deflections shall be conducted and extra care and attention shall be paid to radial thrust capacity of pipe guides, braces, and anchors.

E. Design shall include:

1. Pipe stress analysis indicating loads, deflections, and pipe stress at critical points throughout the piping systems under the following conditions:
 - a. At hydraulic design test pressure and ambient water temperature.
 - b. At design operating temperature, pressure, and flow.
 - c. At design occasional seismic loads where required by the building occupancy and risk category as defined in the state and local code or by the authority having jurisdiction.
 - d. Model number, size, location, and details of expansion joints, compensator guides, supports, braces, and anchorage to building structure, with substantiating calculations that the components and building can accept the calculated loads and deflections.
 - e. Detailed shop drawings stamped and signed by a registered professional engineer.
 - f. Structural details and calculations stamped and signed by a registered professional structural engineer.
 - g. Expansion Joints to be designed and manufactured to the current Expansion Joint Manufacturers Association (EJMA) standards. Manufacturer of expansion joints to be certified by EJMA.

1.05 SUBMITTALS

A. Submit the following:

1. Product Data
2. Shop Drawings showing details of construction, dimensions, arrangement of components, and isolation.
3. Structural Details and Calculations: Submit structural details and calculations substantiating that building structure, anchorages, and fabricated steel braces can safely withstand maximum calculated loads.
4. Specified testing requirements.
5. Operating and Maintenance Data

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Expansion Joints and Compensators:

1. Flexonics
2. Keflex
3. Hyspan
4. Metraflex
5. Other Manufacturers: Submit substitution request.

B. Expansion Loops/Seismic Expansion Joints:

1. Metraflex Metraloop
2. Other Manufacturers: Submit substitution request.

2.02 EXPANSION JOINTS AND COMPENSATORS

- A. Expansion compensators to be of the packless, externally pressurized type to allow for axial movement constructed of stainless steel bellows, stainless steel shroud, integral guide rings, internal liner, limit stops, with drain port and plug.
- B. All materials of construction and pressure ratings shall be appropriate for the application as specified for each piping material and service.

2.03 EXPANSION LOOPS/SEISMIC EXPANSION JOINTS

- A. Description:
 - 1. Flexible stainless steel hose and braid connector.
 - 2. Connector shall accept differential support displacement without damaging pipe, equipment connections, or support connections.
 - 3. All materials of construction and pressure ratings shall be appropriate for the application as specified for each piping material and service.

PART 3 EXECUTION

3.01 EXPANSION JOINTS AND COMPENSATORS

- A. Install piping risers in wood structures to compensate for 1/2-inch of shrinkage per floor. Contractor is responsible to determine quantities and locations required.
- B. Install in piping to compensate for thermal expansion and contraction. Responsible to determine quantities and locations required.
- C. Install in other locations indicated on the drawings.
- D. Provide and install pipe alignment guides as recommended by the expansion joint manufacturer with the first guide no more than 4 pipe diameters away from the expansion joint or compensator and second guide no more than 14 pipe diameters from first guide.
- E. Install per manufacturer's installation instructions.

3.02 EXPANSION LOOP / SEISMIC EXPANSION JOINT

- A. Install at building seismic expansion joints.
- B. Install in piping to compensate for thermal expansion and contraction. Contractor is responsible to determine quantities and locations required.
- C. Install in other locations indicated on the drawings.
- D. Install per manufacturer's installation instructions.

END OF SECTION

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SECTION 23 05 19
METERS AND GAUGES FOR HVAC

PART 1 GENERAL

1.01 SUMMARY

- A. The provisions of this specification are intended to provide requirements as they relate to new equipment and products required to reconfigure and refurbish existing systems as described in the contract documents.
- B. This Section includes:
 - 1. Thermometers - Water
 - 2. Pressure Gauges - General
 - 3. Differential Pressure Gauges

1.02 RELATED SECTION

- A. Division 01, General Requirements
- B. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)

1.03 SUBMITTALS

- A. Submit the following:
 - 1. Products listed in this Section.
 - 2. Operating and Maintenance Data

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Thermometers - Water:
 - 1. Ashcroft
 - 2. Weiss
 - 3. Trerice
 - 4. Marsh
 - 5. Weksler
 - 6. Tel-Tru
 - 7. Other Manufacturers: Submit substitution request.
- B. Pressure Gauges - General:
 - 1. Marsh
 - 2. Ashcroft
 - 3. Weiss
 - 4. Trerice
 - 5. Weksler
 - 6. Tel-Tru

7. Other Manufacturers: Submit substitution request.
- C. Differential Pressure Gauges:
 1. Between Rooms: Dwyer magnahelic Model 2000-00, 0-0.25 inches of water range.
 2. Across Filters: Dwyer magnahelic Model 2002-AF, 0-2.0 inches of water range with air filter gauge accessory package.
- D. Water Meter:
 1. Hersey
 2. Badger
 3. Sparling.
 4. Other Manufacturers: Submit substitution request.

2.02 THERMOMETERS - WATER

- A. Direct mounted 4-1/2-inch dial type, stainless steel case, separable sockets, stem length to penetrate minimum of 1/2 pipe diameter, adjustable face, extension necks where required to clear insulation, accuracy of 1 percent of range.
- B. Range:

HVAC Systems	Temperature	Graduations
Chilled Water	25-125 degrees F	1 degrees F
Condenser Water	25-125 degrees F	1 degrees F
Heating Water	30-240 degrees F	2 degrees F

2.03 PRESSURE GAUGES - GENERAL

- A. Description: 4-1/2-inch dial, molded black polypropylene turret case.
- B. Range:

HVAC Systems	Pressure	Graduations
Chilled Water	0-100 psi	1 psi
Heating Water	0-100 psi	1 psi
Condenser Water	0-100* psi	1 psi
*Provide compound gauge where shown on inlet side of condenser water pump on opening piping systems (30-inches Hg – 15 psi.) Other ranges may be listed on Drawings in which case they take precedence.		

2.04 DIFFERENTIAL PRESSURE GAUGES

- A. Description: Surface mounted diaphragm-actuated dial type with zero pointer adjustment. Provide 4-inch minimum dial diameter with black figures on a white background.
- B. Tubing: Copper; polytube may be used if concealed inside walls.

PART 3 EXECUTION

3.01 INSTALLATION - GENERAL

- A. Provide meters and gauges where shown on Drawings.
- B. Install gauges and meters as required and as recommended by equipment manufacturer or their representative.
- C. Extend connections, wells, cocks, or gauges to a minimum of 1-inch beyond insulation thickness of the various systems.
- D. Locate gauges so that they may be conveniently read at eye level or easily viewed and read from the floor or from the most likely viewing area, i.e., platform, catwalk, etc.
- E. Install instruments over 6-feet-6-inches above floor, to be viewed from the floor, with face at 30 degrees to horizontal.

3.02 INSTALLATION - PRESSURE GAUGES

- A. Provide instrument gauge cock at inlets. Provide protective siphon on steam gauges.
- B. Locate pressure gauge taps for measuring pressure drop or increase across pumps, coils, condensers, etc., as close to the device as possible.

END OF SECTION

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SECTION 23 05 23

GENERAL DUTY VALVES AND SPECIALTIES FOR HVAC

PART 1 GENERAL

1.01 SUMMARY

- A. The provisions of this specification are intended to provide requirements as they relate to new equipment and products required to reconfigure and refurbish existing systems as described in the contract documents.
- B. This Section includes:
 - 1. Ball Valves
 - 2. Butterfly Valves
 - 3. Balancing Valve
 - 4. Strainers
 - 5. related sections
- C. Division 01, General Requirements
- D. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)

1.02 SUBMITTALS

- A. Submit product data.
- B. Submit balancing valve schedule with manufacturer, model, size, flow rate and pressure drop.
- C. PRODUCTS

1.03 MANUFACTURER

- A. General: Where only NIBCO figure numbers are listed, equivalent products by those specified below are acceptable.
- B. Ball Valves:
 - 1. Gruvlok
 - 2. Apollo
 - 3. Crane
 - 4. Hammond
 - 5. Milwaukee
 - 6. Victaulic
- C. Butterfly Valves:
 - 1. Apollo
 - 2. Victaulic
 - 3. Gruvlok
 - 4. Crane
 - 5. Walworth

6. Milwaukee
7. Metraflex
- D. Balancing Valve:
 1. DeZurik
 2. Homestead
 3. Bell and Gossett
 4. Armstrong
 5. Walworth
 6. Taco
 7. Wheatley
 8. Tour & Andersson
 9. Victaulic
 10. Gruvlok
 11. NIBCO
- E. Strainers:
 1. General:
 - a. NIBCO
 - b. Armstrong
 - c. McAlear Mfg. Co.
 - d. Sarco, Inc.
 - e. Mueller
 - f. R.P. & C. Company
 - g. Titan Flow Control
 2. Other Manufacturers: Submit substitution request.
- F. Use one manufacturer on valves.
- G. Threaded, flanged, soldered, or grooved valve ends, as applicable to piping system. Refer to Section 23 21 13, Pipe and Pipe Fittings HVAC for allowable fittings.

1.04 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.
- B. PVC Ball: PVC Body, trunnion mounted, Teflon seat, Viton seals, socket type connection; True Blue GSR Asahi.
- C. Bronze Ball: Bronze cast body, stainless steel full port ball, with handle, Teflon seat, 600 psi WOG, 150 psi steam; NIBCO 585-70-66.

1.05 BUTTERFLY VALVES

- A. Ductile iron body, electroless-nickel chrome plated disc and stainless steel shaft (shaft offset from the disc centerline to provide complete 360-degree circumferential seating), with lever handle and locking feature on valves 6-inches and less, gear operator on valves 8-inches and over; stem neck length to accommodate insulation where applicable, pressure responsive EPDM liner, 300 psi water; Victaulic MasterSeal, NIBCO 2000, NIBCO 4765.
- B. Copper Grooved Piping System Butterfly Valve: Nylon coated or Cast bronze body per Copper Development Agency-836, ductile iron disc encapsulated with EPDM coating, lever handle up to 6-inches, gear operator on valves 8-inches and greater, stem length to accommodate insulation, 300 psi water; Victaulic Series 608, per ASTM A-584.
 - 1. Grooved ends manufactured to copper-tubing sizes. Flaring tube or fitting ends to accommodate alternate sized couplings is not permitted.

1.06 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.

PART 2 EXECUTION

2.01 INSTALLATION

- A. Provide valves at connections to equipment where shown or required for equipment isolation.
- B. Install valves and strainers in accessible locations and same size as connected piping (not the size of the equipment connection), except balancing valves sized by contractor to properly balance the flow.
- C. Provide separate support for valves where necessary.
- D. Provide drain valves in low points in the piping system, at coils and equipment, and as indicated.

2.02 APPLIED LOCATIONS HVAC VALVES

- A. Piping 2-inches and Smaller:

System	Valve Types				
	Gate	Globe	Swing Check	Ball	Butterfly
Chilled Water	Not Allowed	Bronze	Bronze	Bronze	Not Allowed
Heating Water	At Boiler Only	Bronze	Bronze	Bronze	Not Allowed

B. Piping 2-1/2-inches and Larger:

System	Valve Types				
	Gate	Globe	Check	Ball	Butterfly
Chilled Water	Iron	Iron	Iron, Swing	Not Allowed	Ductile Iron
Heating Water	Iron	Iron	Iron, Swing	Not Allowed	Ductile Iron

C. Calibrated balancing valves 2-1/2-inch and smaller, on water coils and in piping systems in accordance with manufacturer's recommendations.

D. Eccentric Plug Valves 3-inch and larger, on water coils and in piping systems in accordance with manufacturer's recommendations.

E. VALVE IDENTIFICATION

F. General: Identify valves to indicate their function and system served.

G. See Section 23 05 53, Identification for HVAC Piping and Equipment.

2.03 INSTALLATION

A. Grooved Mechanical Pipe Valve End Connections:

1. Refer to Section 23 21 13, Pipe and Pipe Fittings HVAC for allowed service installations.
2. Install in accordance with the manufacturer's published installation instructions.
3. Mold and produce gaskets by the coupling manufacturer, and suitable for the intended service.
4. The coupling manufacturer's factory trained representative:
 - a. Provide on-site training for the contractor's field personnel in the use of grooving tools and installation of grooved joint products.
 - b. Periodically visit the project site to ensure best practices in grooved installation are being followed.
 - c. A distributor's representative is not considered qualified to conduct the training or field visits.

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

C. Strainer:

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

3. Applied Locations HVAC:
 - a. Cast iron wye, chilled, heating water,.
 - b. Basket, in piping 2-1/2-inch and larger.

END OF SECTION

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SECTION 23 05 29
HANGERS, SUPPORTS, AND ANCHORS FOR HVAC

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01, General Requirements Specification Sections, apply to this Section.
- B. The provisions of Division 23, Heating, Ventilation and Air Conditioning (HVAC) Section 23 05 00, Common Work Results for HVAC, apply to work specified in this Section.
- C. The provisions of this specification are intended to provide requirements as they relate to new equipment and products required to reconfigure and refurbish existing systems as described in the contract documents.

1.02 SUMMARY

- A. This Section includes Design-Build work.
- B. This Section includes:
 - 1. Supports
 - 2. Anchors
 - 3. Pipe Rollers
 - 4. Insulation Protection Shields
 - 5. Insulation Protection Saddles
 - 6. Building Attachments

1.03 RELATED SECTIONS

- A. Division 01, General Requirements
- B. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)
- C. Section 23 05 48, Vibration and Seismic Controls for HVAC Piping and Equipment
- D. Section 23 07 00, Insulation for HVAC

1.04 QUALITY ASSURANCE

- A. Provide pipe and equipment hangers and supports in accordance with the following:
 - 1. Design supports, anchorages, and seismic restraints for equipment, and supports and seismic restraints for conduit, piping, and ductwork when not shown on the Drawings.
 - 2. Hangers, supports and sway braces to be fabricated in accordance with ANSI B31.1 and MSS SP-58 and SP-89.
 - 3. Use components for intended design purpose only. Do not use for rigging or erection purposes.
 - 4. Seismic restraints and anchorages shall resist seismic forces as specified in the state and local code or by the authority having jurisdiction for the seismic zone in which the project is constructed.

5. Connections to structural framing are not to introduce twisting, torsion, or lateral bending in the framing members. Provide supplementary steel as required.
6. Seismic Restraints:
 - a. Shall not introduce stresses in the piping caused by thermal expansion or contraction to exceed forces or design limits of the piping per ASME B31.9.
 - b. Provided 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. Provided in accordance with the local applicable codes.
 - d. Follow provisions described in Section 23 05 48, Vibration and Seismic Controls for HVAC Piping and Equipment.
7. Piping Connections to Equipment:
 - a. Shall not introduce twisting, torsion, or lateral forces or moments on the equipment.
 - b. Shall be supported and isolated in a manner not to exceed the equipment’s point of connection load limitations.
- B. Engineered Support Systems: Provide design services for the following support systems:
 1. Supports and seismic restraints for suspended piping, ductwork, and equipment.
 2. Support frames such as pipe racks or stanchions for piping, ductwork, and equipment which provide support from below.
 3. Equipment, ductwork, and piping support frame anchorage to supporting slab or structure.

1.05 SUBMITTALS

- A. Submit the following:
 1. Shop Drawings of contractor fabricated support structures.
 2. Structural Details and Calculations:
 - a. Submit structural details and calculations substantiating that building structure, anchorages, and fabricated steel braces can safely withstand maximum calculated loads.
 - b. Details and calculations shall bear the seal of a professional engineer registered in the state having jurisdiction.
 3. No other submittals required under this section.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Supports:
 1. Unistrut
 2. Superstrut
 3. Powerstrut
 4. Kinline

- 5. B-Line Systems
- 6. AnvilStrut
- B. Pipe Hangers:
 - 1. Anvil
 - 2. Superstrut
 - 3. B-Line Systems
 - 4. Tolco
 - 5. ERICO
 - 6. Pipe Shields Inc.
 - 7. Rilco
- C. Pipe Rollers
 - 1. Anvil
 - 2. Super Strut
 - 3. B-Line Systems
 - 4. Tolco
 - 5. ERICO
- D. Insulation Protection Shields
 - 1. Anvil
 - 2. Super Strut
 - 3. B-Line Systems
 - 4. Tolco
 - 5. ERICO
- E. Insulation Protection Saddles
 - 1. Anvil
 - 2. Super Strut
 - 3. B-Line Systems
 - 4. Tolco
 - 5. ERICO
- F. Pipe Guides
 - 1. Anvil
 - 2. B-Line Systems
 - 3. Pipe Shields Inc.
 - 4. Rilco
 - 5. Hyspan

G. Pipe Anchors

1. Anvil
2. B-Line Systems
3. Pipe Shields Inc.
4. Rilco

H. Building Attachments

1. Anvil
2. Elcen
3. Superstrut
4. B-Line Systems
5. Tolco
6. ERICO

2.02 SUPPORTS

- 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. Supports and Accessories: Preformed roll-formed channels and accessories with matching compatible accessories as shown, as specified, and as required.
- C. Dissimilar Metal Protection: Hydra-Zorb cushions or Cush-a-strip.
- D. Clamps: Super Strut Series 700 through 702 or AnvilStrut Series 1000 through 1200.

2.03 PIPE HANGERS

- A. Uninsulated Horizontal Copper Piping:
 1. 2-inch and Smaller: Anvil CT-65, CT-69.
 2. Larger than 2-inch: Anvil 260 field or factory copper plated, plastic coated or other recognized industry methods. Electricians' tape is unacceptable.
- B. Insulated Horizontal Copper Pipe with Hangers Inside of Insulation: Same as Uninsulated Horizontal Copper Pipe.
- C. Insulated Horizontal Copper Pipe with Hangers Outside of Insulation:
 1. 2-inch and Smaller: Anvil 65, 104 or 260.
 2. Larger than 2-inch: Anvil 260.
- D. Other Uninsulated Horizontal Pipe:
 1. 2-inch and Smaller: Anvil 65, 104 or 260.
 2. Larger than 2-inch: Anvil 260.
- E. Other Insulated Horizontal Pipe With Hangers Inside of Insulation:
 1. 2-inch and Smaller: Anvil 65, 104, 260 or 300.

- 2. Larger than 2-inch: Anvil 260.
- F. Other Insulated Horizontal Pipe with Hangers Outside of Insulation:
 - 1. 2-inch and Smaller: Anvil 65, 104 or 260.
 - 2. Larger than 2-inch: Anvil 260.
- G. Riser Clamps Copper Pipe:
 - 1. 4-inch and Smaller: Anvil CT-121, CT-261.
 - 2. Larger than 4-inch: Anvil 261.
- H. Riser Clamps Other Piping: Anvil 261.

2.04 PIPE ROLLERS

- A. Cast Iron roll and sockets, steel roll rod.
 - 1. Anvil 171, 175, 177, 178, 181, or 274 as required.
 - 2. Size for pipe plus insulation for insulated pipe.

2.05 INSULATION PROTECTION SHIELDS

- A. Galvanized carbon steel.
 - 1. Anvil 167.

2.06 INSULATION PROTECTION SADDLES

- A. Carbon steel.
 - 1. Anvil 160 series.
 - 2. Saddles for copper pipe: Factory copper plated.

2.07 PIPE GUIDES

- A. Spider type alignment guide.
 - 1. Anvil 255, 256, 257 & 436
 - 2. Steel Piping:
 - a. Carbon steel housing
 - b. Carbon steel spider clamp
 - 3. Copper Piping:
 - a. Carbon steel housing
 - b. Factory copper plated steel spider clamp

2.08 PIPE ANCHORS

- A. Uninsulated Pipe
 - 1. Pipe Shields Inc. C1000
- B. Insulated Pipe
 - 1. Pipe Shields Inc. C3000 through C4300 series
- C. Pipe Stanchions
 - 1. Anvil 62

2.09 BUILDING ATTACHMENTS

- A. 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.
- B. Inserts: Anvil 152 malleable iron or 281 steel inserts. Inserts sized for required rod to support load being carried.
- C. Expansion Plugs: Similar and equal to Phillips "red-head" self-drilling flush shell selected for safety factor of 4.
- D. Powder actuated fasteners with silencers as approved by Architect.

PART 3 EXECUTION

3.01 HANGERS AND SUPPORTS

- A. General:
 - 1. Install 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 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 piping within 2-feet of each change of direction on both sides of fitting.
- B. Insulated Piping Systems:
 - 1. Refer to Section 23 07 00, Insulation for HVAC 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. Heating Water (over 230 degrees F), Medium Pressure Steam and High Pressure Steam (Non-Vapor Barrier Insulation):
 - a. As specified for Insulated Piping Systems with Vapor Barrier Insulation.
 - 4. Other 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 support locations on piping 1-1/2-inch and larger.
 - c. On piping larger than 2-inch, provide insulation saddles at each support location.
 - 5. 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 Spacing: Provide support at minimum spacing in accordance with state and local codes.
 - 2. Support with U-clamps fastened to wall to hold piping away from wall unless otherwise approved.
 - 3. Provide mid-story vertical guide support where floor to floor distances exceed spacing as required by state and local codes. Riser clamps on steel pipe to be directly welded to pipe. Riser clamps on copper pipe to be installed directly under fitting.
 - 4. Risers that are not subject to thermal change to be supported at each floor of penetration.
 - 5. Risers that are subject to thermal change require engineered supports. Size supports to carry forces exerted by piping system when in operation. Riser supports follow the provisions described in Section 23 05 48, Vibration and Seismic Controls for HVAC Piping and Equipment.
- D. Horizontal Piping:
 - 1. Trapeze Hangers: Multiple pipe runs where indicated supported on channels with rust resistant finish. Provide necessary rods and supporting steel.
 - 2. Support Spacing:
 - a. Provide support at maximum spacing in accordance with state and local codes and any applicable manufacturer requirements.
 - b. Support piping within 2-feet of each change in direction.
 - c. Provide piping with acoustical lagging wrap 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 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 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 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

SECTION 23 05 53
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

- A. The provisions of this specification are intended to provide requirements as they relate to new equipment and products required to reconfigure and refurbish existing systems as described in the contract documents. Only new installations may apply to this section where existing identification has been damaged or is impacted by repair or refurbishment.
- B. This Section includes:
 - 1. Valve Identification
 - 2. Piping Markers
 - 3. Equipment Identification
 - 4. Concealed Equipment Identification

1.02 RELATED SECTIONS

- A. Division 01, General Requirements
- B. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)

1.03 SUBMITTALS

- A. Submit the following:
 - 1. Valve Tag Directory: Submit for approval prior to fabrication of valve tags.
 - 2. Equipment Nameplate Directory: Submit for approval prior to fabrication.
 - 3. 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

2.01 MANUFACTURERS

- A. Piping Markers:
 - 1. W.H. Brady
 - 2. Seton
 - 3. Marking Systems, Inc. (MSI)
 - 4. Other Manufacturers: Submit substitution request.
- B. Concealed Equipment Identification:
 - 1. W.H. Brady
 - 2. Seton
 - 3. Other Manufacturers: Submit substitution request.

2.02 VALVE IDENTIFICATION

A. Valve Tags:

1. General: Identify valves with metal tags, legends to be stamped or embossed. Indicate the function of the valve and its normal operating position; i.e.,

56 HW	(NUMBER AND CONTENT OF PIPE)
ISOLATION	(VALVE FUNCTION)
NO	(NORMAL OPERATION POSITION)

2. Size: Valve tags 2-inch diameter with 1/4-inch high letters.
3. Material: Use 0.04-inch brass tags.
4. Automatic Valves and Regulating Valves:
 - a. Use 1/16-inch thick laminated 3-ply plastic, center ply white, outer ply red, lamicaid, or equal.
 - b. Form letters by exposing center ply.

B. Valve Tag Directory:

1. Tag Number
2. Location
3. Exposed or Concealed
4. Service
5. Valve Size
6. Valve Manufacturer
7. Valve Model Number
8. Normal Operating Position of Valve

2.03 PIPING MARKERS

- A. Label pipes with all-vinyl, self-sticking labels or letters.
- B. For pipe covering sizes up to and including 3/4-inch outside diameter, select labels with 1/2-inch letters.
- C. For sizes from 3/4 to 2-inch outside diameter, 3/4-inch letters, above 2-inches outside diameter, 2-inch letters.
- D. Identify pipe markers and color coded as follows with black directional arrows.

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

2.05 EQUIPMENT IDENTIFICATION

A. Nameplates:

1. Tag pumps, air handling supply units, fans, terminal units, converters, and miscellaneous items of mechanical equipment with engraved nameplates.
2. 1/16-inch thick, 3-inch by 5-inch laminated 3-ply plastic, center ply white, outer ply black. Form letters by exposing center ply.
3. Identify unit with equipment tag as shown on Drawings and area served.
4. Permanently identify access points to fire dampers, smoke dampers, and combination fire and smoke dampers on the exterior of the duct by a label with letters 1/2-inch in height reading the following:
 - a. Fire Damper
 - b. Smoke Damper
 - c. Fire/Smoke Damper
5. Label constructed from same material as equipment nameplates.

B. Equipment Nameplate Directory:

1. List Pumps
2. Air Handlers
3. Terminal Units
4. Other Equipment Nameplates

C. Include Owner and Contractor furnished equipment.

D. List the following on the nameplate:

1. Designation
2. Model Number
3. Location of Equipment
4. Area Served or Function
5. Disconnect Location
6. Normal Position of HOA Switch

2.06 CONCEALED EQUIPMENT IDENTIFICATION

A. 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

3.01 VALVE IDENTIFICATION

A. Valve Tags:

1. Attach to valve with a brass chain.
2. Valve tag numbers continuous throughout the building for each system.

- B. Valve Tag Directory: Post final copy in Operation and Maintenance Manual.

3.02 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 stub out 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. 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.
- C. Apply arrow labels indicating direction of flow.
- D. Arrows the same color and sizes as identification labels.

3.03 EQUIPMENT IDENTIFICATION

- A. Nameplates: Attach to prominent area of equipment, either with sheet metal screws, brass chain, or contact cement as applicable.
- B. Nameplate Directory: Post final copy in Operation and Maintenance Manual.

3.04 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. Valves
 - 2. Pumps
 - 3. Fans

END OF SECTION

SECTION 23 05 93
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.01 SUMMARY

- A. The provisions of this specification are intended to provide requirements as they relate existing systems being repaired or refurbished as described in the contract documents.
- B. 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

1.02 RELATED SECTIONS

- A. Division 01, General Requirements
- B. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)

1.03 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. Accurate Balancing Agency, Inc.
 - 6. Precision Test and Balance, Inc.
- B. Other Firms: Submit substitution requests prior to bid date.

1.04 SUBMITTALS

- A. Submit the following:
 - 1. Balancing Log – Existing Systems: Submit preliminary report indicating existing conditions prior to making any modifications to existing systems.
 - a. Include all air and water outlets, actual field measured air and water volume, and percentage of design volumes.
 - b. Provide drawings identifying location of all outlets.
 - 2. Equipment Data Sheets – Existing Systems: Indicate actual equipment performance, model numbers, bearing and belt data, motor nameplate data, and final balanced motor data.
 - 3. Balancing Log:
 - a. Include all air and water outlets, actual field measured air and water volume, and percentage of design volumes.
 - b. Provide drawings identifying location of all outlets.

4. Equipment Data Sheets: Indicate actual equipment performance, model numbers, bearing and belt data, motor nameplate data, and final balanced motor data.
 5. Additional Data: Submit additional data as provided by Associated Air Balance Council (AABC) Standard forms.
 6. Number of Copies: Submit six copies of the above completed information to the Engineer for review and insertion into the Operating and Maintenance Data.
 7. Instrument Certification: When requested, submit certificate of calibration for equipment to be used.
- B. Record data on NEBB forms or forms approved by the Architect.

1.05 PROJECT CONDITIONS

- A. Where existing systems are to be adjusted, establish flow rates in all branches prior to making any modifications to system. 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.

1.06 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

3.01 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.

3.02 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 OSA and at 100 percent OSA.
 3. Adjust 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 percent. Adjust return fan speed so that return air volumes track with supply air volume minus exhaust air volume.
- D. Distribution:
1. Evaluate all building and room pressure conditions to determine adequate supply and return air conditions. Balance the building 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 balancing dampers.

3.03 HYDRONIC SYSTEMS

- A. General: Make measurements in accord with Industrial Standards specified above. Record on appropriate forms.
- B. 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, and then set mixing control valve to full coil flow.
 3. For each pump:
 - a. Verify rotation.
 - b. Test and record pump shut-off head.
 - c. Test and record pump wide-open head.
 4. Verify proper system pressures.
 5. Verify air vents in high points of water are properly installed and operating freely.

C. 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.

D. Distribution:

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

3.04 AUTOMATIC CONTROL SYSTEM

- A. In cooperation with facility staff, 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.

3.05 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

SECTION 23 05 94
CLEANING OF HVAC EXISTING DUCTWORK

PART 1 GENERAL

1.01 SUMMARY

- A. The provisions of this specification are intended to provide requirements as they relate to existing equipment. System ductwork is intended to be repaired or replaced as indicated in the contract documents, however, cleaning is not required with certain exceptions listed below in this section.
- B. This section defines the minimum requirements necessary to render existing HVAC components clean and to verify the cleanliness through inspection and/or testing in accordance with items specified herein and applicable NADCA Standards. Removal of visible surface contaminants and deposits from within the HVAC system in strict accordance with these specifications.
- C. Return air grilles, the interior surfaces of the AHU, mixing box, coil compartment, condensate drain pans, fans, fan housing, fan blades, turning vanes, filters, filter housings, reheat coils and supply diffusers are considered part of the HVAC system applicable to this scope of work.

1.02 RELATED SECTIONS

- A. Division 01, General Requirements
- B. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)

1.03 QUALITY ASSURANCE

- A. Membership: Certified member of the National Air Duct Cleaners Association (NADCA) or maintain membership in a nationally recognized non-profit industry organization dedicated to the cleaning of HVAC systems.
- B. Certification: Minimum of one Air System Cleaning Specialist (ASCS) certified by NADCA on a full time basis or have staff members certified by a nationally recognized certification program and organization dedicated to the cleaning of HVAC systems.
- C. Supervisor Qualification: Certified as an ACSC by NADCA or maintaining an equivalent certification by a nationally recognized program and organization responsible for the total work herein specified.
- D. Experience:
 - 1. Submit records of experience in the field of HVAC system cleaning as requested by the owner.
 - 2. Bids considered from firms, which are regularly engaged in HVAC system maintenance with an emphasis on HVAC system cleaning and decontamination.

- E. Equipment, Materials and Labor: Possess and furnish necessary equipment, materials, and labor to adequately perform the specified services.
 - 1. Assure that its employees have received safety equipment training, medical surveillance programs, individual health protection measures, manufacturer's product, and material safety data sheets (MSDS) as required for the work by the U.S. Occupational Safety and Health Administration and as described by this specification. For work performed in countries outside of the USA, comply with applicable national safety codes and standards.
 - 2. Maintain a copy of the current MSDS documentation and safety certifications and comply with other site documentation requirements of applicable OSHA programs and this specification.
 - 3. Submit to Owner Material Safety Data Sheets (MSDS) for chemical products proposed to be used in the cleaning process.
- F. Licensing:
 - 1. Provide proof of maintaining the proper license(s).
 - 2. Comply with Federal, state and local rules, regulations, and licensing requirements.

1.04 STANDARDS

- A. NADCA Standards: Perform the services specified here in accordance with the current published standards of the National Air Duct Cleaners Association (NADCA).
 - 1. Terms in this specification have their meaning defined as stated in the NADCA Standards.
 - 2. NADCA Standards must be followed with no modification or deviations being allowed.

1.05 APPLICABLE STANDARDS AND PUBLICATIONS

- A. The following current standards and publications of the issues currently in effect form a part of this specification to the extent indicated by the following references:
 - 1. National Air Duct Cleaners Association (NADCA): Assessment, Cleaning and Restoration of HVAC Systems
 - 2. National Air Duct Cleaners Association (NADCA): Understanding Microbial Contamination in HVAC Systems
 - 3. National Air Duct Cleaners Association (NADCA): Introduction to HVAC System Cleaning Services
 - 4. National Air Duct Cleaners Association (NADCA): Standard 05 Requirements for the Installation of Service Openings in HVAC Systems.
 - 5. Underwriters/ Laboratories (UL): UL Standard 181
 - 6. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE): Standard 62-89 Ventilation for Acceptable Indoor Air Quality
 - 7. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE): Standard 62-89 Ventilation for Acceptable Indoor Air Quality
 - 8. Environmental Protection Agency (EPA): Building Air Quality
 - 9. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA): HVAC Duct Construction Standards – Metal and Flexible

10. North American Insulation Manufacturers Association (NAIMA): Cleaning Fibrous Glass Insulated Air Duct Systems

1.06 SUBMITTALS

- A. Submit qualification of the HVAC System Cleaning Contractor

PART 2 PRODUCTS - NOT APPLICABLE

PART 3 EXECUTION

3.01 HVAC SYSTEM COMPONENT INSPECTIONS AND SITE PREPARATIONS

- A. HVAC System Component Inspection:
1. Prior to the commencement of cleaning work, perform a visual inspection of the HVAC system to determine appropriate methods, tools and equipment required to satisfactorily complete this project.
 2. Cleanliness inspection to include air handling units and representative areas of the HVAC system components.
- B. Conduct cleanliness without negatively impacting the indoor environment through excessive disruption of settled dust, microbial amplification or other debris. In cases where contamination is suspected and/or in sensitive environments where even small amounts of contaminant may be of concern, environment engineering control measures should be implemented.
1. Document and bring to the attention of the Owner damaged system components found during the inspection.
- C. Site evaluation and Preparation: Conduct a site evaluation and establish a specific, coordinated plan, which details how each area of the building will be protected during the various phases of the project.
- D. Inspector Qualifications:
1. Perform the HVAC cleanliness inspection to determine the need for cleaning.
 2. At minimum, such personnel should have an understanding of HVAC system design and experience in utilizing accepted indoor environmental sampling practices, current industry HVAC cleaning procedures, and applicable industry standards.

3.02 GENERAL HVAC SYSTEM CLEANING REQUIREMENTS

- A. Collect and take precautions for containment: debris removed during cleaning to ensure that debris is not otherwise dispersed outside the HVAC system during the cleaning process.
- B. Particulate Collection:
1. Where equipment is exhausting inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron size (or greater) particles.
 2. When exhausting outside the building:
 - a. Mechanical cleaning operations are undertaken only with particulate collection equipment in place, including adequate filtration to contain debris removed from the HVAC system.

- b. Take precautions to locate the equipment down wind and away from air intakes and other points of entry into the building.
- C. Controlling Odors: Take measures to control odors and/or mist vapors during the cleaning process.
- D. Component Cleaning:
 - 1. Visibly clean system components as defined in applicable NADCA Standards.
 - 2. Upon completion, return components to settings recorded just prior to cleaning operations.
- E. Air-Volume Control Devices:
 - 1. Dampers and air-directional mechanical devices inside the HVAC system must have their position marked prior to cleaning.
 - 2. Upon completion restore to their marked position.
- F. Service Openings:
 - 1. Utilize service openings, as required for proper cleaning, at various points of the HVAC system for physical and mechanical entry and inspection.
 - 2. Utilize the existing service openings already installed in the HVAC system where possible.
 - 3. Create openings where needed and seal in accordance with industry codes and standards.
 - 4. Closures must not significantly hinder, restrict, or alter the airflow within the system.
 - 5. Closures must be properly insulated to prevent heat loss/gain or condensation on surfaces within the system.
 - 6. Openings must not compromise the structural integrity of the system.
 - 7. Construction techniques used in the creation of openings should conform to requirements of applicable building and fire codes, applicable NFPA, SMACNA, and NADCA Standards.
 - 8. Reopen service openings for future inspection or remediation clearly marked and have their location reported to the owner in project report documents.
- G. Ceiling Sections (Tile): Remove and reinstall ceiling sections to gain access to HVAC systems during the cleaning process.
- H. Air Distribution Devices (Registers, Grilles and Diffusers): Clean air distribution devices.
- I. Air Handling Units, Terminal Units (VAV, Dual Duct Boxes, etc.), Blowers and Exhaust Fans:
 - 1. Ensure that supply, return and exhaust fans and blowers are thoroughly cleaned.
 - 2. Areas to be cleaned include the following:
 - a. Blowers
 - b. Fan Housings
 - c. Plenums, with the exception of ceiling supply and return plenums.
 - d. Scrolls
 - e. Blades or Vanes
 - f. Shafts

- g. Baffles
- h. Dampers
- i. Drive Assemblies
- 3. Remove visible surface contamination deposits in accordance with NADCA Standards:
 - a. Clean air handling units (AHU) internal surfaces, components and condensate collectors and drains.
 - b. Ensure that a suitable operative drainage system is in place prior to beginning wash down procedures.
 - c. Clean coils and related components, including evaporator fins.

3.03 HEALTH AND SAFETY

- A. Safety Standards:
 - 1. Comply with applicable federal, state, and local requirements for protecting the safety of the contractor's employees, building occupants, and the environment.
 - 2. Follow applicable standards of the Occupational Safety and Health Administration (OSHA) when working in accordance with this specification.
- B. Occupant Safety: Do not employ processes or materials in such a manner that they will introduce additional hazards into occupied spaces.
- C. Disposal of Debris: Remove debris from HVAC system disposed of in accordance with applicable federal, state, and local requirements.

3.04 MECHANICAL CLEANING METHODOLOGY

- A. Source Removal Cleaning Methods:
 - 1. Clean HVAC system using Source Removal mechanical cleaning methods designed to extract contaminants from within the HVAC system and safely remove contaminants from the facility.
 - 2. Select Source Removal methods that will render the HVAC system visibly clean and capable of passing cleaning verification methods (see applicable NADCA Standards) and other specified test, in accordance with general requirements.
 - 3. No cleaning method or combination of methods used which could potentially damage components of the HVAC system or negatively alter the integrity of the system.
 - a. Methods used incorporate the use of vacuum collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of the section being cleaned through a predetermined opening. Use sufficient power to render areas cleaned under negative pressure.
 - b. Equip vacuum devices exhausting air inside the building with HEPA filters (minimum efficiency) including hand-held vacuums and wet-vacuums.

- c. Equip vacuum devices exhausting air outside the facility with Particulate Collection including adequate filtration to contain Debris removed from the HVAC system. Exhaust in a manner that will not allow contaminants to re-enter the facility. Release of debris outdoors must not violate outdoor environment standards, codes, or regulations.
 - d. Methods require mechanical agitation devices to dislodge debris adhere to interior HVAC system surfaces, such that debris may be safely conveyed to vacuum collection devices. Acceptable methods will include those, which will not potentially damage the integrity of the ductwork, nor damage porous surface materials such as liners inside the ductwork or system components.
- B. Methods of Cleaning Fibrous Glass Insulated Components:
 - 1. Fibrous glass thermal or acoustical insulation elements present in equipment or ductwork thoroughly cleaned with HEPA vacuuming equipment, while the HVAC system is under constant negative pressure and not permitted to get wet in accordance with applicable NADCA and NAIMA standards and recommendations.
 - 2. Cleaning methods used not to cause damage to fibrous glass components and will render the system capable of passing Cleaning Verification Tests.
- C. Damage Fibrous Glass Material:
 - 1. Evidence of damage: Identify for replacement evidence of damage, deterioration, delaminating, friable material, mold, or fungus growth, or moisture such that fibrous glass materials cannot be restored by cleaning or resurfacing with an acceptable insulation repair coating.
 - 2. Replacement:
 - a. When requested or specified.
 - b. Capable of remediating exposed damaged insulation in air handlers and/or ductwork requiring replacement.
 - 3. Replacement Material: In the event fiberglass materials must be replaced, and conform to applicable industry codes and standards, including those of UL and SMCNA.
 - 4. Replacement of damaged insulation is not covered by this specification.
- D. Cleaning of Coils:
 - 1. Cleaning method may be used which will render the coil visibly clean and capable of passing coil cleaning verification.
 - 2. Coil drain pans subject to nonporous surfaces cleaning verification. Keep drain for the condensate drain pan operational.
 - 3. Cleaning methods not to cause appreciable damage to, displacement of, inhibit heat transfer or erosion of the coil surface or fin and conform to coil manufacturer recommendations when available.
 - 4. Rinse coils completely with clean water to remove latent residues.

E. Antimicrobial Agents and Coatings:

1. Apply antimicrobial agents if active fungal growth is reasonably suspected or where unacceptable levels of fungal contamination have been verified through testing.
2. Perform application of antimicrobial agents used to control the growth of fungal or bacteriological contaminants after the removal of surface deposits and debris.
3. Apply antimicrobial treatments and coatings in strict accordance with the manufacturers' written recommendations and EPA registration listing.
4. Apply according to the manufacturer's written instructions. Spray coatings directly onto interior ductwork surfaces, rather than fogged downstream onto surfaces.

3.05 CLEANLINESS VERIFICATION

- A. General: Verification of HVAC system cleanliness will be determined after mechanical cleaning and before the application of treatment or introduction of treatment related substance to the HVAC system, including biocidal agents and coatings.
- B. Visual inspection: Visually inspect to ensure that no visible contaminants are present.
1. If no contaminants are evident through visual inspection, considered clean, however, the owner reserves the right further verify system cleanliness through Surface Comparison Testing or the NADCA vacuum test specified in the NADCA Standards.
 2. If visible contaminants are evident through visual inspection, those portions of the system where contaminants are visible re-cleaned and subjected to re-inspection for cleanliness.
 3. NADCA vacuum test analysis should be performed by a qualified third party experienced in testing of this nature.
- C. Verification of Coil Cleaning:
1. Cleaning must restore the coil pressure drop to within 10 percent of the pressure drop measured when the coil was first installed.
 2. If original pressure drop is not known, the coil will be considered clean only if the coil is free of foreign matter and chemical residue, based on a thorough visual inspection (see NADCA Standards).

3.06 PRE-EXISTING SYSTEM DAMAGE

- A. Provide notice of pre-existing systems damage to owner prior to Work.

3.07 POST-PROJECT REPORT

- A. At the conclusion of the project, provide a report to the owner indicating the following:
1. Success of the cleaning project, as verified through visual inspection and/or gravimetric analysis.
 2. Areas of the system found to be damaged and/or in need of repair.

END OF SECTION

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SECTION 23 07 00
INSULATION FOR HVAC

PART 1 GENERAL

1.01 SUMMARY

- A. The provisions of this specification are intended to provide requirements as they relate to new equipment and products required to reconfigure and refurbish existing systems as described in the contract documents.
- B. This Section includes:
 - 1. Pipe Insulation
 - 2. Ductwork Blanket Insulation
 - 3. Accessories Piping
 - 4. Accessories Ductwork

1.02 RELATED SECTIONS

- A. Division 01, General Requirements
- B. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)
- C. Section 23 05 29, Hangers, Supports and Anchors for HVAC
- D. Section 23 31 01, HVAC Ducts and Casing – Low Pressure

1.03 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Prohibit insulating products 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 or ASTM E84.
 - 3. Energy Codes: Local Building and Energy Codes govern where insulation performance requirements for thickness exceeds thickness specified.
- B. Protection:
 - 1. Protect against dirt, water, chemical, or mechanical damage before, during, and after installation.
 - 2. Repair or replace damaged insulation.
- 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 not to provide nutritional or bodily use to fungi, bacteria, insects, rats, mice, or other vermin, not to react corrosively with equipment, piping, or ductwork, and asbestos free.

1.04 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

- A. Manufacturers
 - 1. Pipe Insulation:
 - a. Fiberglass:
 - 1) Johns Manville Microlok HP
 - 2. Ductwork Blanket Insulation:
 - a. Fiberglass:
 - 1) Johns Manville Microlite Type 100
 - b. Semi-Rigid Fiberglass:
 - 1) Johns Manville Micro-Flex
 - c. Elastomeric:
 - 1) Armacell Armafle

2.02 PIPE INSULATION

- A. Fiberglass: Split sectional or Snap-On type with 0.23 per-inch maximum thermal conductivity (K-factor) at 75 degrees F mean temperature, 850 degrees F maximum service rating and white, vapor barrier jacket with pressure sensitive closure system.

2.03 DUCTWORK BLANKET INSULATION

- A. Fiberglass: 1.0 pcf nominal density, 0.25 per-inch maximum K-factor at 75 degrees F mean temperature, 250 degrees F minimum operating temperature limit.
 - 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.

2.04 ACCESSORIES PIPING

- A. Adhesives:
 - 1. General: Maximum Flame Spread/Smoke Developed Rating of 25/50, SCAQMD Rule 1168 compliant.
 - 2. Fiberglass: Integral closure system.
 - 3. Calcium Silicate: Benjamin Foster 30-36.
 - 4. Elastomeric: Armacell 520 BLV.
- B. Cements:
 - 1. Insulating: Ryder.
 - 2. Heat Transfer: Chemax Tracit-300.

- 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. Grooved Coupling Insulation: One piece PVC insulated fitting cover. Zeston, Ceel-Co.
- F. Metal Pipe Jacket: 0.016-inch thick aluminum jacket with formed fitting covers, aluminum snap straps and sealant.
- G. Cloth Facing: Presized fiberglass cloth.
- H. Tapes: Pressure sensitive, weather resistant, and for temperatures up to 150 degrees F. Zeston Z-tape.
- I. Paint: Ultraviolet resistant latex paint with special adherence capabilities to the PVC fitting covers, elastomeric, aluminum facing, Kraft paper, tapes, and adhesives.

2.05 ACCESSORIES DUCTWORK

- A. Adhesives:
 - 1. General: Maximum Flame Spread/Smoke Developed Rating of 25/50, SCAQMD Rule 1168 compliant.
 - 2. Fiberglass: Benjamin Foster 85-62, Design Polymeric 2501/2502
 - 3. Elastomeric: Armacell 520 BLV
 - 4. Duct Insulation, Internal: Foster 85-62, Design Polymeric 2501/2502
- B. Weld Pins: Duro-Dyne with NC-1 nylon stop clips
- C. Cements:
 - 1. Insulating: Ryder.
 - 2. Heat Transfer: Chemax Tracit-300
- 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 degrees F. Zeston Z-tape.
- H. Paint: Ultraviolet resistant latex paint with special adherence capabilities to the PVC fitting covers, elastomeric, aluminum facing, Kraft paper, tapes, and adhesives.

PART 3 EXECUTION

3.01 GENERAL

- A. Workmanship:
 - 1. Installation: Insulation installed in first class, neat professional manner.
 - 2. Applicators: Employ by firm that specializes in insulation work.

- B. Preparation: Surfaces of piping, ductwork, 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 not covered.

3.02 HVAC PIPE AND EQUIPMENT INSULATION APPLIED LOCATIONS

- A. Insulation Applied Locations – HVAC Piping:

System	Pipe Size	Insulation Type	Insulation Thickness	Notes
Heating Water (to 200 degrees F)	1-1/4-inch and smaller	Fiberglass	1-1/2-inch	Note 1
Heating Water (to 200 degrees F)	1-1/2-inch and above	Fiberglass	2-inch	Note 1
Heating Water (to 250 degrees F)	3-1/2-inch and smaller	Fiberglass	2-1/2-inch	Note 1
Heating Water (to 250 degrees F)	4-inch and above	Fiberglass	3-inch	Note 1
Chilled Water	1-1/4-inch and smaller	Fiberglass	1-inch	Note 1
Chilled Water	1-1/2-inch and above	Fiberglass	1-1/2-inch	Note 1
Note 1: Cover with metal pipe jacket where exposed to weather and over heat trace cable. Note 2: Refer to specification 23 20 14 for additional pre-insulated piping systems requirements. Note 3: Elastomeric insulation not allowed over heat trace cable.				

- B. Include fittings, unions, flanges, mechanical couplings, valve bodies, valve bonnets, piping through sleeves, except valve bonnets, unions and flanges need not be insulated on the following systems:
 - 1. Hot water heating, inside building.
 - 2. Chilled water cooling, inside building.
- 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 insulated with section of pipe insulation and insulating cement, securely fastened, and finished with 6 ounces canvas and Foster 30-36 lagging adhesive.
- E. Option on 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 ounces 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 SS lacing wire.
- F. Expansion Joints and Flexible Connectors: Pipe insulation or block of same material and thickness as adjacent piping.

3.03 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:
 - a. Fill voids, chipped corners and other openings with insulating cement or material compatible with insulating material.
 - b. 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. Fittings: Insulation specified with continuous vapor barrier, the vapor barrier must not be violated.

1. On Elastomeric 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.

D. 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.

E. Vapor Barrier Insulation:

1. Refer to Section 23 05 29 Hangers, Supports, and Anchors for HVAC, for support requirements.
2. Piping which requires vapor barrier protection has a continuous vapor barrier, which may not be pierced or broken. The following piping systems require vapor barrier protection:
 - a. Chilled water including radiant cooling water.

- b. Brine water.
 - c. Refrigerant suction.
 - d. Other piping systems with a nominal operating temperature below 65 degrees 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 23 05 29, Hangers, Supports, and Anchors for HVAC.
- F. Non-Vapor Barrier Insulation:
 - 1. Refer to Section 23 05 29, Hangers, Supports, and Anchors for HVAC for support requirements.
 - 2. Insulation may be interrupted at supports. Butt insulation tight to support.
 - 3. Continue insulation at supports, installation as specified for piping systems with vapor barrier installation.
 - 4. Void between saddle and pipe filled with insulation.

3.04 EQUIPMENT INSTALLATION

- A. General: Install true and smooth. Insulation over curved surfaces conform to curves of surface.
 - 1. Access:
 - a. Insulated removable heads, water boxes, pump casings, access, etc., that require service, inspection or maintenance provided with covers or section that are easily removable and replaceable.
 - b. Reinforce openings in adjacent insulation with metal beading.
 - c. In vapor barriered insulation, coat joints with vapor barrier mastic.
 - 2. Voids, Depressions and Cavities: Voids, chipped corners and other openings filled with insulating cement or material compatible with insulating material.
 - 3. Vapor Barriered Insulation:
 - a. Where insulation is specified to have a vapor barrier.
 - b. No broken or pierced barrier.
 - 1) Coated with vapor barrier mastic and patched with insulation facing or tape.
 - 2) Staples brush coated with vapor barrier coating.
 - 3) Raw edges coated with vapor barrier mastic covered and cover sealed to equipment surface.
 - 4. Non-Vapor Barriered Insulation:
 - a. Patch with insulation facing or tape.
 - b. Cover raw edges and neatly bevel to the equipment surface.

5. Multilayered Insulation: With staggered joints.
- B. Expansion Joints:
1. 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.

3.05 DUCT INSULATION APPLIED LOCATIONS

- A. General:
1. External insulation with continuous vapor barriers unless specifically noted otherwise.
 2. Internally 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
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	Note 3
	Concealed or in mechanical rooms	All	Fiberglass Blanket	1-1/2-inch	
	Exposed Outside Building Envelope	All	Internally Lined	3-inch	Note 3
	Under Slab Ductwork	All	Internally Lined	2-inch	
	Downstream of Air Terminal Units	All	Internally Lined	1-1/2-inch	Note 1 Note 3
	15-feet upstream and downstream of fans	All	Internally Lined	1-1/2-inch unless otherwise indicated	Note 3
Return Air* (not insulated except)	Concealed Outside Building Envelope	All	Externally insulated without vapor barrier	2-inch	
	Exposed Outside Building Envelope	All	Internally Lined	2-inch	Note 3
	Under Slab Ductwork	All	Internally Lined	2-inch	Note 3

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

* In addition to applied locations listed in this table, provide internally lined ductwork where indicated on drawings.

Note 1: Except ductwork downstream of terminal units serving patient care areas in hospitals

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 round/oval ductwork as specified in Section 23 31 02, HVAC Ducts and Casing-Medium Pressure, or provide internally lined rectangular ductwork with equivalent free area may be substituted.

3.06 DUCTWORK INSTALLATION

A. General:

1. Install in accordance with manufacturer's instruction.
2. Continuous vapor barrier. Coat 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.
4. Support:
 - a. Duct enclosure may be hung from a conventional trapeze arrangement.
 - b. Provide adequate support at the bottom of vertical runs.

- c. Multi-Story Vertical Runs: Support Firetemp enclosure at each story penetration with an angle iron collar attached to the Firetemp.
- 5. Expansion: Provide adequate clearance at the end of straight runs to allow for expansion of the metal duct inside the enclosure.
- B. Plenums: Insulation on floors protected by wire mesh.
- C. Blank-Off Panels: Insulation, enclosed with sheet metal on all sides. Joints with vapor barrier mastic and taped.
- 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.

3.07 FIELD QUALITY CONTROL

- A. 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, repair as required by this specification.

END OF SECTION

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SECTION 23 31 01
HVAC DUCTS AND CASING-LOW PRESSURE

PART 1 GENERAL

1.01 SUMMARY

- A. The provisions of this specification are intended to provide requirements as they relate to new equipment and products required to reconfigure and refurbish existing systems as described in the contract documents.
- B. This Section includes:
 - 1. Supports, Anchorage And Restraints
 - 2. Sheet Metal Ductwork
 - 3. Flexible Ducts
 - 4. Exposed or Visible Ductwork In Finished Spaces

1.02 RELATED SECTIONS

- A. Division 01, General Requirements
- B. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)
- C. Section 23 05 48, Vibration and Seismic Controls for HVAC Piping Equipment
- D. Section 23 07 00, Insulation for HVAC
- E. Section 23 33 00, Air Duct Accessories

1.03 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 UL 181 listed, Class I air duct, flame rating not to exceed 25 and smoke rating not to exceed 50.

1.04 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 materials and construction details for single wall housing plenum.
 - 4. Provide shop drawings showing construction details, support, and seismic restraint of ductwork distribution systems.

PART 2 PRODUCTS

2.01 SUPPORTS, ANCHORAGE AND RESTRAINTS

- A. General:
 - 1. Provide design for supports, anchorages, and seismic restraints for equipment when not shown on the Drawings.
 - 2. Supports, anchorage and restraints provided are required to 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. Follow provisions in Section 23 05 48, Vibration and Seismic Control for HVAC Piping and Equipment for seismic restraints.
 - 4. Seismic restraints are not to introduce stresses in the ductwork caused by thermal expansion or contraction.
 - 5. Connections to structural framing are not to introduce twisting, torsion, or lateral bending in the framing members. Provide supplementary steel as required.
- B. Suspended Ductwork: Provide seismic restraints 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: Provide designs and details for the following support systems with 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.

2.02 SHEETMETAL DUCTWORK

- A. Fabricate from galvanized steel, unless noted otherwise.
- B. Minimum gauge, duct construction, joint reinforcing, fittings, hangers, and supports in accordance with SMACNA HVAC Duct Construction Standards – Metal and Flexible, Latest Edition.
- C. Duct Classification: Ducts considered low pressure when design velocities are 2000 fpm or less and maximum static pressure is 2-inches wg positive or negative.
 - 1. The following ductwork constructed in accordance with minimum reinforcement requirements for static pressure class of 2-inches wg, positive or negative.
 - a. Supply, return, or exhaust ductwork.
- D. 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.
- E. Use of adjustable round elbows not permitted.

2.03 FLEXIBLE DUCTS

- A. 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.

- B. Duct rated for 6-inch wg positive and 1-inch wg negative.

2.04 EXPOSED OR VISIBLE DUCTWORK IN FINISHED SPACES

A. Round:

1. Material:

- a. Round or flat oval, machine formed, spiral lock-seam galvanized sheet metal ductwork of thicknesses as listed for sheet metal duct.
 - b. Paintable surface.
- #### **2. Fittings: Machine formed, shop fabricated, with welded seams, designed for easiest air flow, similar to United Sheet Metal numbers listed.**
- a. Mitered Elbow with Turning Vanes: Type EV-90-2.
 - b. Radius Elbows: Type E090-5. Similar for less than 90 degree elbows.
 - c. Tees: Type Con-T-1.
 - d. Reducing Fittings: May be used unless noted otherwise.

B. Rectangular:

- 1. Same as for sheet metal ductwork but paintable surface.
- 2. Inside reinforcing.
- 3. Use special care to prevent imperfections in the metal surface.

PART 3 EXECUTION

3.01 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. Provide supplementary steel for support of ductwork in shafts and between building structural members.
- 4. 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, splitter vanes.
- 5. Change in duct size or shape necessitated by interference made using rectangular equivalents of equal velocity.
- 6. 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. Dampers:** Install where shown and where necessary to complete final balancing of system. Install regulators as specified in Section 23 33 00, Air Duct Accessories for each specific project condition. Leave dampers locked wide open in preparation for balancing.

- C. Flexible Connectors: Make connections to fans and other rotating equipment with flexible connectors with 2-inch minimum clearance between casing and ductwork. Not required on internally spring isolated units.
- 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 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. Changes in direction 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).
- F. Ductwork, Exposed or Visible in Finished Areas:
 - 1. Use extreme care in handling and installing.
 - 2. Replace dented or damaged sections.
 - 3. Install ductwork straight and true, parallel to building lines.
 - 4. Make connections with pop rivets using couplings where applicable. Grind raw edges smooth and apply paintable sealant to cover imperfections.
 - 5. Remove excess sealant to provide a finished joint.
 - 6. Provide floor, wall, and ceiling plates as specified in Section 23 05 00, Common Work Results for HVAC.
 - 7. Finish, clean and prime ductwork, and hangers for painting.

3.02 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 sheet metal dampers.
 - 2. Install missing dampers required to complete final balancing.

END OF SECTION

SECTION 23 33 00
AIR DUCT ACCESSORIES

PART 1 GENERAL

1.01 SUMMARY

- A. The provisions of this specification are intended to provide requirements as they relate to new equipment and products required to reconfigure and refurbish existing systems as described in the contract documents.
- B. This Section includes:
 - 1. Low Pressure Duct Accessories

1.02 RELATED SECTIONS

- A. Division 01, General Requirements
- B. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)
- C. Section 23 31 01, HVAC Ducts and Casing-Low Pressure

1.03 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. Flexible connectors, flexible equipment connections, 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.

1.04 SUBMITTALS

- A. Submit the following: Product data for Duct Accessories.
 - 1. Low Pressure Duct Accessories:
 - a. Constant Airflow Regulators
 - b. Access Doors
 - c. Backdraft Dampers
 - d. Automatic Dampers
- B. Operation and Maintenance Data: Automatic dampers.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Low Pressure Duct Accessories:
 - 1. Flexible Equipment Connector:
 - a. Duro Dyne Corporation
 - b. Ventfabrics

2. Access Doors:
 - a. Air Balance
 - b. Ruskin
 - c. Metco
 - d. Duro Dyne Corporation
 - e. Cesco
 - f. Nailor-Hart
 - g. Or approved equal.

2.02 LOW PRESSURE DUCT ACCESSORIES

- A. Damper Regulators:
 1. Acceptable Manufacturers:
 - a. Ventlok
 - b. Young
 - c. Duro Dyne Corporation
 - d. Approved equal
 2. Dial Regulator – Concealed or exposed duct in unfinished spaces:
 - a. Blade lengths 18-inch and less: 3/8-inch shaft
 - b. Blade lengths 19-inches and above: 1/2-inch shafts
 - c. Ventlok 635, or 638 for insulated duct.
 3. Dial Regulator – Exposed duct in finished space:
 - a. 3/8-inch shaft
 - b. Ventlok 640
 4. Dial Regulator – Concealed or non-accessible duct:
 - a. Blade lengths 18-inch and less: 3/8-inch shaft
 - b. Blade lengths 19-inches and above: 1/2-inch shafts
 - c. Ventlok 666 regulator with 680 mitered gear assembly where right angled turn is necessary.
 5. End Bearings:
 - a. Ducts rated to 1-inch WG, open end, Ventlok 607.
 - b. Ducts rated above 1-inch WG, closed end, Ventlok 609.
 - c. Exposed ductwork, finished spaces, Ventlock 609.
 - d. Spring end bearings not allowed.

B. 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 by 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.

C. Flexible Equipment Connector:

1. Description: Woven fiberglass fabric with neoprene coating, air-tight, water-tight, fire retardant.
2. Minimum Density: 30 oz. per sq. yd.
3. Temperature Range: -20 degrees F to 200 degrees F
4. Pressure Range: -10-inch wg to +10-inch wg

D. Spin-in Fittings:

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

E. Duct Sealer:

1. Based On:
 - a. McGill Airseal Zero
 - b. Design Polymeric DP 1090
2. Description:
 - a. Suitable for indoor/outdoor use, including application in moist conditions, rated to 10-inch wg.
 - b. Maximum Flame Spread/Smoke Developed Rating of 25/50, maximum VOC of 420 g/L less water.
 - c. SCAQMD Rule 1168 compliant.

F. Duct Tape for Sheet Metal:

1. ARNO C520 duct tape similar United
2. Duro Dyne Corporation
3. Nashua

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

H. Access Doors:

1. Doors complete with steel frame, steel door with backing plate, cam latches (two on units 14-inch by 14-inch and larger), hinge, and gasketing. Insulate doors on insulated or lined ducts.
2. Size:

Duct Width or Duct Diameter	Net Access Door Opening
Up to 8-inch	6-inch by 6-inch
9-inch to 12-inch	8-inch by 8-inch
13-inch to 20-inch	12-inch by 12-inch
21-inch to 30-inch	16-inch by 14-inch
31-inch to 42-inch	18-inch by 14-inch
Over 42-inch	Two 16-inch by 14-inch

I. Automatic Dampers:

1. Description:
 - a. Multi-blade air foil type, except where either dimension is less than 10-inches a single blade may be used. Maximum blade length to be 48-inches.
 - b. Provide parallel blades for positive or modulating mixing service and opposed blades for throttling service.
 - c. Blades to be interlocking, minimum 16 gauge galvanized steel.
2. Compression type edge seals and side seating stops.
3. Reinforced blades, have continuous full length axle shafts, axle to axle linkage, and/or operating jackshafts to provide coordinated tracking of blades.
4. Dampers over 25 square-feet in area to be in two or more sections, with interconnected blades. Maximum air leakage of 3 cfm per square foot at 1-inch wg pressure.
5. Provide automatic dampers except those specified to be provided with units. Tested in accordance with AMCA Standard 500. Based on Ruskin CD-60.
6. Damper Operators: Reuse or replace existing as needed.
7. Manufacturers:
 - a. Ruskin
 - b. Greenheck
 - c. Air Balance
 - d. Cesco
 - e. Or equal.

PART 3 EXECUTION

3.01 INSTALLATION

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

- B. Low Pressure Duct Accessory installation specified under Section 23 31 01, HVAC Ducts and Casing-Low Pressure.
- C. Access Doors: Install where indicated and at duct mounted coils, humidifiers, automatic control dampers, smoke dampers, fire dampers, air flow stations, to provide access for cleaning and maintenance.
- D. Automatic Dampers:
 - 1. Install where indicated.
 - 2. Coordinate new/existing damper operators with facility staff and engineer.

END OF SECTION

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SECTION 23 37 00
AIR OUTLETS AND INLETS

PART 1 GENERAL

1.01 SUMMARY

- A. The provisions of this specification are intended to provide requirements as they relate to new equipment and products required to reconfigure and refurbish existing systems as described in the contract documents.
- B. This Section includes:
 - 1. Diffusers and Grilles

1.02 RELATED SECTIONS

- A. Division 01, General Requirements
- B. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)
- C. Section 23 33 00, Duct Accessories

1.03 SUBMITTALS

- A. Submit the following:
 - 1. Shop Drawings: Showing dimensions and details of construction.
 - 2. Product Data

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Where only Titus figure numbers are listed, equivalent products by the following manufacturers by using only one:
 - 1. Carnes
 - 2. Price
 - 3. Krueger
 - 4. Tuttle & Bailey
 - 5. Anemostat
 - 6. Nailor
 - 7. Other Manufacturers: Submit substitution request.

2.02 DIFFUSERS AND GRILLES

- A. Ceiling Supply Diffuser (C-1):
 - 1. Perforated face 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).
 - 2. White baked enamel finish, Titus PMC.

- B. Ceiling Return/Exhaust Grille (C-2): Perforated face modular ceiling grille, steel panel, with duct adapters for round or rectangular as indicated, lay-in tee bar ceiling, or surface mounted as required (coordinate with architectural reflected ceiling plan), white baked enamel finish, Titus PAR.
- C. Drum Louver (H-1):
 - 1. Drum louver with 1-1/4-inch steel borders, (opposed blade dampers), counter sunk screw holes, extruded aluminum drum, rotatable 25 degrees up/down from centerline, individually adjustable blades, white baked enamel finish.
 - 2. Titus model DL.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install 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 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 outlets flat black.

3.02 PERFORMANCE

- A. Unit sizing is based on air being introduced at 20 degrees 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 degrees F. Units are also selected so as not to exceed the NC-30 curve.

END OF SECTION

SECTION 26 05 00
COMMON WORK RESULTS FOR ELECTRICAL

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 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".

1.03 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.

1.04 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 switch legs 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.

1.05 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. Fire alarm system.
 - c. Lighting system.
 - d. Lighting control 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.

1.06 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. 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.

1.07 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.

1.08 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 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.

1.09 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.

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

2.01 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

3.01 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.

3.02 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.

3.03 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.

3.04 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.

3.05 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.

3.06 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.

3.07 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".

3.08 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.

3.09 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 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.
 - 9. Power metering and monitoring system.
- E. Provide a written record of performance tests and submit with operation and maintenance data.

END OF SECTION

SECTION 26 05 19

LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. The provisions of Division 26 Section, Common Work Results for Electrical, apply to this section.

1.02 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 26 05 26, Grounding and Bonding for Electrical Systems.
 - 2. Section 26 05 33, Raceways and Boxes for Electrical Systems.
 - 3. Section 26 05 53, Identification for Electrical Systems.

1.03 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.

1.04 SUBMITTALS

- A. Submit product data for the following materials:
 - 1. Single conductor 600-volt power and control conductors.
 - 2. 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

2.01 CONDUCTORS – 600V

- A. Type:
 - 1. Copper: No. 12 AWG minimum size unless noted otherwise. No. 12 and No. 10, stranded, No. 8 or larger, Class B concentric or compressed stranded.
 - 2. Aluminum: No. 1/0 AWG minimum size unless noted otherwise. Compact stranded conductors, AA-8000 series electrical grade aluminum alloy.
 - 3. Conductors with continuous colored jackets are acceptable, refer to color coding in section 3.
 - 4. Conductors with a manufacturers "no lube" continuous jacket coatings are acceptable.
- 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.

2.02 POWER LIMITED WIRING

- A. Copper, stranded for trade sizes No. 12 or greater, solid for trade sizes less than No. 12 or as recommended by the system manufacturer.
- B. Insulation shall be appropriate for the system and location used.

2.03 MC BRANCH CIRCUIT CABLE

- A. Sheath: High strength galvanized steel, of the interlocking metal type, continuous and close fitting. The sheath shall not be considered a current carrying or grounding conductor.
- B. Conductors: Copper, stranded for trade sizes No. 12 or No. 10, solid for trade sizes less than No. 12, of the same ampacity as the conduit/wire system indicated for the specific location. Provide equipment grounding conductor in all cable. Provide separate green insulated grounding conductors in circuits where an isolated ground is called for.
- C. Provide HCF rated cable for health care facility construction as code required.
- D. Manufacturers: AFC Cable systems, Southwire, Okonite.

2.04 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

3.01 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.
- E. For remodel work or where shared neutrals are used by equipment such as systems furniture, provide a breaker handle tie as required for the phases sharing the neutral conductor.

3.02 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. Provide all enclosures and terminals to transition from MC cable to building wire as required.
- C. MC cable is allowed only within a room space containing an accessible ceiling.
- D. MC cable is not allowed within kitchens or other wet environments.
- E. Horizontal runs of MC cable is not allowed to be installed under windows due to inaccessible replacement.

3.03 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.

3.04 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	480 volt 480Y/277 volt
Black	A	Brown
Red	B	Orange
Blue	C	Yellow
White	Neutral	Gray*
Green	Ground**	Green
* or white with colored (other than green) tracer		
**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.

3.05 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 DC, and record and maintain the results, in tabular form, clearly identifying each conductor being tested as part of the final documentation back to the owner.
 - 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

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SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. The provisions of Division 26 Section, Common Work Results for Electrical, apply to this section.

1.02 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 26 05 19 Low Voltage Electrical Power Conductors and Cables.
 - 2. Section 26 05 33 Raceways and Boxes for Electrical Systems.
 - 3. Section 26 27 26 Wiring Devices.
 - 4. Section 26 29 00 Motor Controllers.

PART 2 PRODUCTS

2.01 GROUND CONDUCTORS

- A. Green insulated copper for use in conduits, raceways, and enclosures.
- B. Bare copper for ground grids and grounding electrode systems.

2.02 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.

2.03 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.

2.04 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

3.01 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.

3.02 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.

3.03 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.

3.04 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.

3.05 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

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SECTION 26 05 29
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. The provisions of Division 26 Section, Common Work Results for Electrical, apply to this section.

1.02 SUMMARY

- A. This section describes supporting devices for electrical equipment, associated conduit, and cable.
- B. Related Sections include:
 - 1. Section 26 05 33 Raceways and Boxes for Electrical Systems.
 - 2. Section 26 50 00 Lighting.

1.03 REFERENCED STANDARDS

- A. International Building Code (IBC)
- B. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)

PART 2 PRODUCTS

2.01 PRODUCTS

- A. Hangers: Kindorf B-905-2A channel, H-119-D washer, C105 strap, minimum 1/2-inch rod with ceiling flange.
- 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

3.01 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.

3.02 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 luminaires 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 luminaires weighing 56 pounds or more directly from the structure above with approved hangers attached to each corner of the luminaire.

3.03 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.

3.04 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. Raceways are secured at intervals required for the type of raceway installed.
 5. Cables and raceway are secured to independent support wires by fastening devices and clips designed for the purpose.
 6. 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

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SECTION 26 05 33
RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 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.

1.02 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 26 05 19 Low Voltage Electrical Power Conductors and Cables.
 - 2. Section 26 05 26 Grounding and Bonding for Electrical Systems.
 - 3. Section 26 05 29 Hangers and Supports for Electrical Systems.
 - 4. Section 26 05 53 Identification for Electrical Systems.

PART 2 PRODUCTS

2.01 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.

2.02 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 651 and carry appropriate UL listing for above and below ground use.

2.03 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.

2.04 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 26 05 26.
 - 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.

2.05 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.
- 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.

2.06 NON-METALLIC BOXES

- A. PVC, molded enclosures, threaded hubs.

PART 3 EXECUTION

3.01 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.

3.02 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.

3.03 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.

3.04 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.

3.05 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.

3.06 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

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SECTION 26 05 53
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. The provisions of Division 26 Section Common Work Results for Electrical, apply to this section.

1.02 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 26 05 19 Low Voltage Electrical Power Conductors and Cables.
 - 2. Section 26 05 33 Raceways and Boxes for Electrical Systems.
 - 3. Section 26 27 26 Wiring Devices.
 - 4. Section 26 29 00 Motor Controllers.
 - 5. Section 26 50 00 Lighting.
 - 6. Section 28 30 00 Fire Detection and Alarm.

PART 2 PRODUCTS

2.01 LABELS

- A. Pre-printed: Permanent material pre-printed with black on white, with adhesive backing, Brady, 3M, or ETC.
- 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.
- D. Wire Markers: White with black numbers, adhesive backed tape on dispenser roll, Brady, 3M.
- 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

3.01 GENERAL

- A. Nameplate and text coloring:
 - 1. Normal: Black nameplate with white lettering.
 - 2. Emergency: Red nameplate with White lettering.
 - 3. Standby: Yellow nameplate with black lettering.
 - 4. UPS: Blue nameplate with white lettering.

3.02 BRANCH CIRCUIT PANELBOARDS

- A. Provide engraved laminated plastic nameplate on the face and the inside 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 and face of the panel door below the engraved laminated plastic nameplate.
- 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.

3.03 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

3.04 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.

3.05 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.

3.06 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.
- C. Label all interiors of boxes that have a device in them with marker pen identifying system fed from.

3.07 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.

3.08 EXISTING EQUIPMENT

- A. Provide new nameplates and labels for existing distribution equipment in accordance with the 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, type written, circuit directories where circuiting changes are made.

END OF SECTION

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SECTION 26 27 26
WIRING DEVICES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. The provisions of Division 26 Section, Common Work Results for Electrical, apply to this section.

1.02 SUMMARY

- A. This Section includes: Wiring devices and plates for all outlet boxes shown.
- B. Related Sections include:
 - 1. Section 26 05 19 Low Voltage Electrical Power Conductors and Cables.
 - 2. Section 26 05 26 Grounding and Bonding for Electrical Systems.
 - 3. Section 26 05 33 Raceways and Boxes for Electrical Systems.
 - 4. Section 26 05 53 Identification for Electrical Systems.
 - 5. Section 26 05 80 Electrical Testing.

1.03 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

2.01 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.

2.02 WALL SWITCHES

- A. Acceptable Manufacturers: 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. Pass & Seymour.
- 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.
 - 2. Emergency power: Red.
 - 3. Standby power: Red.

2.03 RECEPTACLES

- A. Acceptable Manufacturers: Hubbell, Leviton, 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 tamper-resistant as noted on the drawings or NEC required.
 - 2. Provide isolated ground as noted on the drawings or NEC required.
 - 3. Provide with (2) port USB 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 tamper-resistant as noted on the drawings or where NEC required.
 - 2. Provide weather-resistant rating at exterior locations as required by NEC.
- D. USB-type: (4) USB ports minimum, 5 Amp, 5V DC, type A, class 2.0. Switch activated port door; when open enables power. When closed, all power is switched off, for a "zero" no-load draw.
 - 1. Green LED indicator to show USB power available.
 - 2. USB stainless steel ports rated for minimum 10,000 insertions and removals.
 - 3. Complies with battery charging specification BC1.2.
 - 4. Compatible with USB 1.1/2.0/3.0 devices.
- E. Clock Outlets: As noted on the drawings and compatible with the specified clock system.
- F. Special Purpose Receptacles: As noted on Drawings with NEMA configurations.
- G. Except as noted herein, device exposed finish color shall be as follows:
 - 1. Normal power: Gray.
 - 2. Emergency power: Red.

3. Standby power: Red.
4. Isolated Ground: Orange
5. Surge Suppression: Blue

2.04 PLATES

- A. Acceptable Manufacturers: Hubbell, Leviton, Pass & Seymour.
- B. Flush Finish Plates: Tamper resistant cold rolled steel with baked polyester powder enamel finish. Secure with 4 stainless steel flat head screws. Provide Torx head screws in special education locations.
- 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 260553 Identification for Electrical Systems.

2.05 OCCUPANCY SENSORS

- A. Acceptable Manufacturers: Watt Stopper. Watt Stopper series numbers are identified herein to establish the minimum level of quality for each product. Manufacturer substitutions required to be approved by the Beaverton School District.
- 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

3.01 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.

3.02 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.

3.03 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.

3.04 OCCUPANCY SENSORS

- A. Low voltage occupancy sensors shall be provided when installed in accessible ceiling systems.
- B. 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.

- C. Provide additional sensing heads as necessary or per manufacturer's recommendation to achieve complete coverage of each room.
- D. Set sensitivity as required to provide small movement coverage throughout the room without extending coverage beyond the room.
- E. System performance testing shall be done with the sensor timing set to the time delay available.
- F. 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.
- G. 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.

3.05 TESTING

- A. Receptacles shall be tested for line to neutral, line to ground and neutral to ground faults. Correct any defective wiring.

END OF SECTION

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SECTION 26 29 00
MOTOR CONTROLLERS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. The provisions of Division 26 Section, Common Work Results for Electrical, apply to this section.

1.02 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 26 05 19 Low Voltage Electrical Power Conductors and Cable.
 - 2. Section 26 05 26 Grounding and Bonding for Electrical Systems.
 - 3. Section 26 05 53 Identification for Electrical Systems.

1.03 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

2.01 ACCEPTABLE MANUFACTURERS

- A. Motor Control Centers, Motor Starters and Visible Blade Disconnects: Same manufacture as the distribution equipment specified in Section 26 24 13, Allen Bradley or approved equivalent.
- B. Horsepower Rated Toggle Switches: Arrow Hart, General Electric, Hubbell, Pass & Seymour.

2.02 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 packs. 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.

2.03 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 I 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.

2.04 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.

2.05 POWER MODULE (ELEVATOR SHUNT TRIP)

- A. Motor rated, fused power switch (size as indicated on drawings) with integral shunt trip attachment, control power transformer, control power fuses and blocks, fuse covers, key to test, pilot lights and fire alarm interface relay to NEMA I enclosure for emergency shutdown of elevator power. Provide auxiliary contacts for elevator battery lowering device to sense if power module was manually or unintentionally turned-off. Bussmann #PS series, Littelfuse, Ferrazshaw-Mersen or approved.

PART 3 EXECUTION

3.01 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.

3.02 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.

3.03 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.

3.04 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

SECTION 26 50 00

LIGHTING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. The provisions of Division 26 Section, Common Work Results for Electrical, apply to this section.

1.02 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 26 05 19 Low Voltage Electrical Power Conductors and Cables.
 - 2. Section 26 05 26 Grounding and Bonding for Electrical Systems.
 - 3. Section 26 27 26 Wiring Devices.

1.03 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 012 50 0 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 or PCB/Driver, and lamp sockets.
 - 5. Appearance
 - a. Architectural integration.
 - b. Light tightness.
 - c. Neat, trim styling.
 - d. Conformance with design intent.

1.04 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

2.01 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.

2.02 LENSES

- A. Prismatic Acrylic:
 - 1. 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.

2.03 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.

2.04 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 Ellipses. 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-prorated 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-prorated warranty is required on all electronic components.

2.05 EMERGENCY LED DRIVERS

- A. Consist of a high-temperature, replaceable maintenance-free nickel cadmium battery, integral charger, and electronic circuitry enclosed in single compact case. Provide solid-state charging indicator light to monitor the charger and battery, a double-pole test switch, and installation hardware.
- B. Emergency driver operates lamps for a minimum of 90 minutes in the emergency mode. Lumen output at end of 90 minutes, 60 percent of initial lumen output per UL924.
- C. UL listed for installation either inside or on top of the luminaire and be warranted for a full five years from date of installation.
- D. Install and wire by the luminaire manufacturer unless specified for field installation in the Luminaire Schedule.
- E. Wire as either Nightlight (always on) or switchable (with power failure sensing feed) as shown on the drawings.
- F. Mount in accordance with manufacturer's installation requirements.
- G. Initial lumen output to be full output of the luminaire rating.
- H. 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.
- I. Testing: LED luminaires must meet the IES LM-79-08 and LM 80-08 testing requirements. The manufacturer shall provide verification of testing compliance upon request of the design team, contractor or owner.
- J. 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

3.01 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. 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.

3.02 COORDINATION OF WORK

- A. The Architectural Reflected Ceiling Plans shall take precedence 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.

3.03 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.

3.04 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.

END OF SECTION

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SECTION 27 05 00
COMMON WORK RESULTS FOR COMMUNICATIONS

PART 1 GENERAL

1.01 SUMMARY

- A. Work included in Section 270500 applies to Division 27 – Communications work to provide materials, labor, tools, permits, incidentals, and other services to provide and make ready for Owner's use of communications systems for proposed project:
- B. Contract Documents include, but are not limited to, Specifications including Division 00, Procurement and Contracting Requirements and Division 01 – General Requirements, Drawings, Addenda, Owner/Architect Agreement, and Owner/Contractor Agreement. Confirm requirements before commencement of work.
- C. The Division 27, Communications, and the accompanying Drawings are complementary, and what is called for by one binding as if by both.
 - 1. Items shown on the Drawings are not necessarily included in the Specifications and vice versa.
- D. Provide components, materials, services, and labor essential for a complete and functional structured cabling system.
- E. Comply with local, state, and federal laws and regulations applicable to the work to be performed although said law, rule, or regulation is not identified herein.
- F. Additional conditions apply to this Division including, but not limited to:
 - 1. Specifications including General and Supplementary Conditions and Division 01, General Requirements.
 - 2. Drawings
 - 3. General provisions of the Contract
 - 4. Addenda
 - 5. Owner/Architect Agreement
 - 6. Owner/Contractor Agreement
 - 7. Codes, Standards, Public Ordinances and Permits
- G. Communications Systems
 - 1. Pathways & Grounding/Bonding for new Communications Systems
 - 2. Structured Cabling System
 - a. Removal and new horizontal cabling, patch panels and faceplates in renovated areas of the building. New horizontal cabling, patch panels, and faceplates in new/addition areas.
 - b. Protecting-in-place existing backbone cabling.
 - c. Patch cables to support 100% port activation.

3. Public Address System
 - a. Selective demolition of PA speakers in areas of renovation.
 - b. New PA speakers in all renovated areas.

1.02 RELATED SECTIONS

- A. Division 01, General Requirements
- B. Division 26, Electrical
- C. Division 27, Communications
- D. Division 28, Electronic Safety and Security

1.03 REFERENCES

- A. References, Codes and Standards per Division 00 – Procurement and Contracting Requirements and Division 01 – General Requirements, individual Division 27 Sections and those listed in this section.
- B. Supervisors and Lead Installers:
 1. Working knowledge and understanding of the following documents and codes or their most recent updates and familiar with the requirements that pertain to this installation.
 2. Installers familiar with and have practical working knowledge of the requirements that pertain to this installation.
- C. Codes:
 1. Comply with applicable sections of the most recent editions and addenda of following for interior and exterior installations.
 2. Codes to include latest adopted editions, including current amendments, supplements and local jurisdiction requirements in effect as of the date of the Contract Documents, of/from:
 - a. IBC International Building Code
 - b. NEC/NFPA 70 National Electrical Code
 - c. NFPA 72 National Fire Alarm and Signaling Code
 - d. NEXC IEEE National Electrical Safety Code
 3. State of Oregon:
 - a. OAR Oregon Administrative Rules
 - b. OESC Oregon Electrical Specialty Code
 - c. OFC Oregon Fire Code
 - d. OSSC Oregon Structural Specialty Code
 - e. OEESC Oregon Energy Efficiency Specialty Code
 - f. Oregon Elevator Specialty Code
- D. Standards:
 1. Comply with applicable sections of the most recent editions and addenda of the following for installations and testing of communications cabling, connectors, and related hardware.

2. Meet or exceed applicable referenced standards, federal, state, and local requirements and conform to codes and ordinances of authorities having jurisdiction.
3. Reference standards and guidelines include but are not limited to the latest adopted editions from the following:
 - a. ANSI American National Standards Institute
 - b. NEMA National Electrical Manufacturers Association
 - c. TIA Telecommunications Industries Association
 - 1) TIA TSB-125 Guidelines for Maintaining Optical Fiber Polarity Through Reverse-Pair Positioning
 - 2) TIA TSB-140 Additional Guidelines for Field-Testing Length, Loss and Polarity of Optical Fiber Cabling Systems
 - 3) TIA-526-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant – OFSTP-7
 - 4) T-526-14-B Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant – SFSTP-14
 - 5) ANSI/TIA-568-C.0 Generic Telecommunications Cabling for Customer Premises
 - 6) ANSI/TIA-568-C.1 Commercial Building Telecommunications Cabling Standard, Part 1: General Requirements
 - 7) ANSI/TIA-568-C.2 Commercial Building Telecommunications Cabling Standard, Part 2: Balanced Twisted Pair Cabling Commercial Building Telecommunications Cabling
 - 8) ANSI/TIA-568-C.3 Commercial Building Telecommunications Cabling Standard, Part 3: Fiber Optic Cabling Components Standards
 - 9) ANSI/TIA-569-B Commercial Building Standards for Telecommunications Pathways and Spaces
 - 10) ANSI/TIA-598-C Optical Fiber Cable Color Coding
 - 11) ANSI/TIA-604.2-AFOCIS 2—Fiber Optic Connector Intermateability Standard
 - 12) ANSI/TIA-606-A Administration Standard for Commercial Telecommunications Infrastructures
 - 13) ANSI/TIA/607-B Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
 - 14) ANSI/TIA-758-A Customer-owned Outside Plant Telecommunications Infrastructure Standard
 - 15) ANSI/TIA-854 A Full Duplex Ethernet Specification for 1000 Mb/s (1000BASE-TX) Operating over Category 6 Balanced Twisted-Pair Cabling
 - 16) ANSI/TIA-862-B Structured Cabling Infrastructure Standard for Intelligent Building Systems

17) ANSI/TIA-4994 Standard for Sustainable Information Communications Technology

18) ANSI/NECA/BICSI 568-2006 Standard for Installing Telecommunications Systems

d. Other Reference Materials

1) ANSI/NECA/GICSI-568-2006, Standard, Installing Commercial Building Telecommunications Cabling

2) COOSP BICSI - Outside Plant Design Reference Manual

3) ESSDRM BICSI - Electronic Safety and Security Reference Manual

4) ITSIM BICSI - Information Transport Systems Installation Methods Manual

5) NDRM BICSI - Network Design Reference Manual

6) TDDM BICSI - Telecommunications Distribution Methods Manual

7) WDRM BICSI - Wireless Design Reference Manual

8) IEEE Institute of Electrical and Electronic Engineers

9) NEMA National Electrical Manufacturers Association

10) UL Underwriters Laboratories Cable Certification and Follow Up Program

11) ASA American Standards Association

4. Beaverton School District Technical Standards

a. Refer to Division 27: Communications & Technology link on this website:

<https://www.beaverton.k12.or.us/depts/facilities/development/Pages/Technical%20Standards.aspx>

b. BSD-approved deviations from this Standard will be discussed at the pre-construction coordination meeting.

1.04 QUALITY ASSURANCE

A. Perform work in accordance with contract documents and governing codes and standards.

B. Structured Cabling System Work

1. Personnel performing the work of this Section thoroughly familiar with the cabling methods set forth in the latest release of the TDDM.

2. RCDD reviews required work prior to commencing. Oversee the installation and will have the end responsibility for the quality of the installation work performed. Submitted designs and or changes to the design must be approved and signed off by the RCDD.

3. Expansion Capability: Unless otherwise indicated, provide spare positions in wall fields, cross connects, and patch panels, as well as space in distribution and riser pathways to accommodate minimum 15 percent future growth.

C. Installed cabling systems not to generate nor be susceptible to harmful electromagnetic emission, radiation, or induction that degrades cabling systems.

- D. Backward Compatibility: The provided solution backward compatible with lower category ratings such that if higher category components are used with lower category components, the permanent link and channel measures meet or exceed the lower channel's specified parameters.
- E. Component Compliance: The provided solution's components each meet the minimum transmission specifications listed herein such that no individual component will be less than specifications for permanent and channel, regardless of the fact that tests for permanent and channel ultimately meet required specifications.
- F. Visibly damaged goods are to be returned to the supplier and replaced at no additional cost to the Owner.

1.05 CONTRACTOR RESPONSIBILITY AND QUALIFICATIONS

- A. Approved Contractor:
 - 1. At a minimum the contractor, possess the following qualifications:
 - a. Possess those licenses/permits required to perform telecommunications installations in the State of Oregon.
 - b. Be an approved Certified Installer at a Plus tier and be qualified to install and provide the product's warranty.
 - c. The copper installation and termination crew must be certified by the manufacturer.
 - d. Submit references of the type of installation provided in this specification.
 - e. Personnel trained and certified in fiber optic cabling, splicing, termination, and testing techniques. Personnel must have experience using a light meter and OTDR.
 - f. Personnel trained in the installation of CAT 6 and CAT 6a rated pathways and support for housing horizontal, backbone, and campus cabling.
 - g. Personnel fluent in the use of Computer Aided Design (CAD) and possess and operate CAD software using DWG format
 - h. On data/telecommunications Projects with a contract value of \$100,000.00 or more, the Contractor shall have a BICSI certified RCDD on staff or access to one under contract for Project design certification and management.
- B. Examination of building and site responsibility:
 - 1. Examine site and building prior to bid to determine conditions affecting the scope of work. Contact Owner representative for arrangements.
 - 2. Systems and cabling are assumed working and in good condition unless Contractor documents exceptions.
- C. Respect and protect the privacy and confidentiality of Owner, its employees, processes, products, and intellectual property to the extent necessary, consistent with the legal responsibilities of the State of Oregon and Owner policies.
- D. Use of Sub-Contractors:
 - 1. Inform in writing to Owner's representative and General Contractor about the intention to use sub-contractors and the scope of work for which they are being hired.

2. Owner's representative prior to the sub-contractor's hiring and start of work must approve the use of sub-contractors in writing.
- E. Provide a sufficient number of technicians for this project to stay on schedule.

1.06 CHANGE ORDERS

- A. Supplemental cost proposals by the Contractor accompanied with a complete itemized breakdown of labor and materials. At the Architect's request, Contractor's estimating sheets for the supplemental cost proposals made available to the Architect.
- B. Separate and allocate labor for each item of work.

1.07 WARRANTY

- A. The chosen Communications Contractor provide a minimum 1 year warranty on material, installation, and workmanship.
- B. Provide a written warranty covering the work of this Division as required by the General Conditions.
- C. Documentation declaring Manufacturer's Warranty on Structured Cabling System shall be provided to the District within 30 days of finished installation.
- D. 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.
- E. Include in Contractor's warranty for Work of Division 27, Communications system damage caused by failures of system component.

1.08 SUBMITTALS

- A. Prior to the start of work, the Structured Cabling Contractor shall:
 1. Submit copies of the certification of the company and names of staff that will be performing the installation and terminations.
 2. Receive approval from PAE and the BSD Representative on all substitutions of material.
- B. Post-Installation and Test System Documentation:
 1. Upon completion of the installation provide three full documentation sets to the BSD Representative for approval.
 2. The BSD Representative may request that a 10 percent random field re-test be conducted on other cable systems, at no additional cost, to verify documented findings. Tests shall be a repeat of those defined above. If findings contradict the documentation submitted by the telecommunications Contractor, additional testing can be requested to the extent determined necessary by the BSD Representative, including a 100 percent retest. This re-test shall be at no additional cost to the District.

C. Test Results:

1. Clearly mark test results as Project Test Documentation with the Project name and the date of completion (month and year). The results shall include a record of test frequencies, cable type, conductor pair and cable (or outlet) I.D., measurement direction, reference setup, and crew member name(s). The test equipment name, manufacturer, model number, serial number, software version, and last calibration date will also be provided at the end of the document. Unless the manufacturer specifies a more frequent calibration cycle, an annual calibration cycle is required on all test equipment used for this installation. The test document shall detail the test method used and the specific settings of the equipment during the test, as well as, the software version being used in the field test equipment.
2. The field test equipment shall meet the requirements of ANSI/TIA-568-C series, including applicable TSB's and amendments. The appropriate Level 3 tester shall be used to verify CAT 5e, CAT 6 and CAT 6a cabling systems.
3. Test results generated for each cable by the wire (or fiber) test instrument shall be submitted as part of the documentation package. The Telecommunications Contractor must furnish this information in electronic form (CD-ROM or Data DVD).
4. When repairs and re-tests are performed, the problem found and corrective action taken shall be noted. Both the failed and passed test data shall be documented.

D. As-Built Drawings:

1. The As-Built Drawings are to include cable routes and outlet locations. Outlet locations shall be identified by their sequential number (BSD data drop labeling scheme, Frame - Patch Panel- Port Number (Example: F2-P1-12)) as defined in this standard. For renovation work in existing buildings, the BSD Representative will provide floor plans in paper and electronic (current AutoCAD version) formats on which As-Built construction information can be added.
2. As-Built documentation and test results must be received 20 working days (4 weeks) prior to Substantial Completion to allow staff occupancy of the facility.

E. General:

1. Guidelines set forth in this Section pertain to Division 27, Communications specifications included in this project.
2. Submit the following deliverables to the Owner and Design Team prior to ordering equipment or installation of equipment.
3. Partial submittals will not be considered, reviewed, or stored, and such submittals will not be returned.
4. Materials and equipment listed that are not in accordance with specification requirements and/or not prior approved may be rejected.
5. The approval of material, equipment, systems, and shop drawings is a general approval subject to the Drawings, Specifications, and verification of measurements at the job. Approval does not relieve the Contractor from the responsibility of shop drawing errors. Carefully check and correct shop drawings prior to submission for approval.

F. Informational Submittals:

1. Field Test Reports:

- a. Submit sample cable test reports showing report format and parameters tested.
- b. Submit minimum of 2 weeks prior to final punch walkthrough. Maintain test equipment on-site during punch for sample proof-of-performance tests.

2. Proposed test forms for fiber backbone, copper backbone, and horizontal UTP cable.

3. Certificates:

- a. Certify that field tests have been performed and that work meets or exceeds specified requirements.
- b. 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.
- c. Optical loss budget calculations for each optical fiber run.
- d. Calibration report of test equipment for fiber and copper. Last calibration date should not be older than one year from the first day of testing.
- e. Name(s) and copy of installer's certificates as it pertains to the system design (e.g. RCDD, CTS, NICET, etc.).

G. Shop Drawings:

- 1. Original bid contract documents are not to be used as shop drawings. Generate their original shop drawings utilizing CAD software (i.e. AutoCAD, Revit, etc.)
- 2. Shop drawings that appear to be traces or overlays of original bid contract documents immediately rejected.
- 3. Where scope is distributed among multiple sub-contractors, each sub-contractor's submittal makes reference the other submittal where connections to equipment provided by other sub-contractors is required.
 - a. Example: Contractor A provides System X shop drawings. Contractor B provides System Y shop drawings. Both sets of shop drawings must make references to each other where systems X or Y are interdependent on each other to function.
- 4. General Requirements:
 - a. Clear and legible
 - b. Utilize the same sheet size as the contract drawings.
 - c. Use minimum of 1/8-inch text height for text, symbol text, and subscript text.
 - d. Plan drawings utilize the same scale as issued in the contract documents.
 - e. Plan drawings utilize the same sheet order as issued in the contract documents.
 - f. Plan drawings utilize the same grid-line locations relative to the sheet as issued in the contract document (this is to aid overlay and checking of shop drawings vs. contract documents and to aid the as-built documentation).

- g. Sheets, including the cover sheet include a title block containing the following information:
 - 1) System specific sheet number
 - 2) Project name, specification section number, and Section title name
 - 3) Floor name, area, and/or floor description matching that of the contract drawings.
 - h. Include architectural information on the shop drawings including, but not limited to the following:
 - 1) Match Lines
 - 2) Grid Lines
 - 3) Grid Bubbles
 - 4) Key Plans
 - 5) Enlarged Floor Plan Callouts
5. Cover Sheet:
- a. The first page of shop drawings includes a coversheet containing the following information:
 - 1) Site Information:
 - a) Name of Site
 - b) Address
 - c) City
 - d) Zip Code
 - 2) Installing Contractor's Information:
 - a) Business Name
 - b) Local Office Address
 - c) Phone Number
 - d) Website
 - e) Primary Contact Person:
 - (1) Name
 - (2) Phone Number
 - (3) Email Address
 - b. Provide sheet index on the coversheet.
6. Legends:
- a. Symbols:
 - 1) Shop drawings include an associated symbol for each device used on the symbol legend, including but not limited to the following:
 - a) Symbol Name
 - b) Device Description

- c) Rough-in Requirements
 - d) Applicable Manufacturer
 - e) Manufacturer's Model Number
 - b. Wiring:
 - 1) Shop drawings include an associated symbol for each wire used on the symbol legend, including but not limited to the following:
 - a) Cable Designator
 - b) Cable Manufacturer
 - c) Model Number
 - d) Cable Rating (e.g. CMP, CMR, OSP, etc.)
 - e) Size of Conductors
 - f) Quantity of Conductors
 - 2) Each cable type has a different designation.
- 7. Plans and Elevations:
 - a. Plan Views:
 - 1) Devices, cabinets, racks, and termination blocks.
 - 2) Raceways (conduits, cable trays, ladder racks, floor ducts, junction boxes, pull boxes, splice boxes, manholes, and associated supports).
 - 3) Field devices with their respective address number.
 - 4) IP addresses for TCP/IP devices included in the system.
 - 5) Equipment clearances for racks/cabinets.
 - b. Elevation Views:
 - 1) Termination blocks, patch panels, wire managers, and other devices.
 - 2) Vertical and horizontal offsets and transitions.
 - 3) Vertical elevation of cable trays above the floor or bottom of ceiling structure.
 - 4) Clearances for access above and to side of cable trays.
 - 5) Rack Layouts
 - a) Intended equipment layout within the racks.
 - b) Blank filler plates in spaces where equipment is not installed.
 - c) Areas within the rack for equipment furnished by or reserved by others.
 - d) Indicate rack unit size of equipment, and total rack units available in the rack.
- 8. Details and Diagrams:
 - a. Details:
 - 1) Mounting details for head-end equipment, racks, and field devices.

- b. Diagrams:
 - 1) Associated one-line or riser diagram showing connections between devices and connections to equipment provided in other systems.
 - 2) Indicate cable type, sizes, and quantities between each TR for backbone copper and fiber cabling.
 - 3) Show field devices with their respective room names/numbers and connections to their associated equipment.
 - 4) Show field devices with their respective address number.
 - 5) Show IP addresses for TCP/IP devices included in the system.
- 9. System Labeling Schedules:
 - a. Electronic copy of labeling schedules, in software and format selected by Owner.
- 10. Deferred Submittals:
 - a. Mounting Details:
 - 1) Provide engineering analysis, calculations, and drawing details of device restraints and supports for maximum loading in compliance with Code and coordinated with all trades.
 - 2) Details to show loads, connection type/materials, dimensions, etc., specific to each unique installation instance.
 - 3) Details to indicate both expected and maximum loads.
 - 4) Analysis to adhere to seismic bracing requirements in the jurisdiction specific to the project.
 - 5) Details to be stamped and signed by an Engineer licensed for the applicable work in the project's area of jurisdiction.
 - 6) Provide details for:
 - a) Floor mounted equipment racks, including raised floor supports.
 - b) Cable tray, runway, and wire-basket tray.
 - c) Ceiling and Wall:
 - (1) Supported flat panel displays.
 - (2) Supported projectors and projection screens.
 - d) Roof-mount devices, braced to withstand maximum wind gusts and uplift pressures.
 - e) Conduit and junction boxes infrastructure systems.
 - f) Antennas and satellite dishes.
 - g) Other ceiling and wall supported devices weighing more than 20 pounds.
- H. Equipment/Product Data Submittals:
 - 1. Submit a single package of the related submittals for the products called out in Division 27, Communications 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. Submitted digitally (e.g. in PDF) and have digital bookmarks for navigating the document set, organized as follows:
 - a. Primary division (e.g. 27)
 - 1) Submittal section (e.g. 271500)
 - a) Product name (e.g. "PATCH PANELS")
4. For each applicable section within the Division 27, Communications, organize as follows:
 - a. Cover sheet for each applicable section number.
 - 1) Include the contractor's contact information
 - b. Table of contents with the following information per line:
 - 1) Equipment Type
 - 2) Manufacturer
 - 3) Model Number
 - 4) Page Number (with hyperlink to product data sheet's page)
 - c. Apply header to each page of each sections submittals including the following:
 - 1) Title of Division 27 section the products fall under (e.g. 271500 –Communications Horizontal Cabling).
 - d. Apply footer to the bottom of each submittal package including the following:
 - 1) Clearly labeled page numbers
 - 2) Date of submittal (YYYY-MM-DD)
5. Where more than one product is called out on the same sheet, clearly highlight or mark which product is proposed for use.

1.09 PRODUCT ASSURANCE

- A. UL and/or ETL approved and labeled in accordance with NEC for products where labeling service normally applies.
- B. Label materials and equipment requiring UL 94, 149, or 1863. Modification of products that nullifies UL labels is not permitted.
- C. Materials and equipment provided by standard Commercial-Off-The-Shelf (COTS) products of a manufacture engaged in the manufacture of such products.
- D. Typical commercial designs that comply with the requirements specified. Materials and equipment readily available through manufacturers and/or distributors. Supply equipment complete with optional items required for proper installation.
- E. Materials or Manufactures not listed in this Division 27 – Communications but are required materials to provide a complete and functioning cable infrastructure system have cut sheets and product data included in the material and procedures submittal package.

- F. Coordinate the features of materials and equipment so they form an integrated system. Match components and interconnections for optimum future performance and backward compatibility.
- G. Test fiber cable while on the reel prior to installation of the cable. Assume liability for replacement of cable should it be found defective at this time or a later date prior to customer acceptance.

1.10 COORDINATION

- A. Coordinate arrangement, mounting, and support of communications equipment with Architect, Communication Design Professional or Owner Information Technology Team:
 - 1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
 - 2. To provide the most efficient pathway for structured cabling endpoint devices such that the cabling never exceeds the 295-foot permanent link distance. Pathways must be shown on shop drawings for review prior to installation.
 - 3. To provide for ease of disconnecting the equipment with minimum interference to other installations.
 - 4. To allow right-of-way for piping and conduit installed at required slope.
 - a. Racks and Communication Cabinets: 3-foot minimum.
 - b. Open Pathways – Cable Tray, J-Hooks: 12-inch clear on working side; 3-inch clear from ceiling tiles.
 - c. Closed Pathways – Conduit (Above and Below Grade):
 - 1) 3-inch clear from electrical pathways concrete encased.
 - 2) 12-inch clear in electrical pathways in dirt.
 - 3) 48-inch clear electrical Motors and transformers.
- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- C. Coordinate location of access panels and doors for communications items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 – Openings.
- D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 – Thermal and Moisture Protection.
- E. Responsible for coordination with all trades, to include required scheduling of materials and/or equipment with Owner and/or General Contractor for delivery, storage, and protection of equipment as required.
- F. Finishes: Where specific device finishes have not been identified, selected by Owner or Architect, finish to match surrounding surfaces.

1.11 ALTERNATES, SUBSTITUTIONS, AND CHANGE ORDERS

- A. If a proposed alternate material submitted as an “or approved equal” to or exceeds specified requirements, provide manufacturer’s specifications in writing for written approval prior to purchase and installation of proposed materials. The proposed material substitution not void or change manufacturer’s warranty.
- B. Provide a complete cabling infrastructure according to these written specifications and drawings. Changes from the Owner changes the scope of work to be performed by the Contractor, put in writing. Respond to changes with a complete material list, labor, and taxes in writing presented to the Owner for approval. Do not proceed with additional scope of work without a signed approval by the Owner.
- C. Additional work performed by the Contractor will not be paid by Owner without signed approval of these changes prior to implementing changes. Submit a copy of signed change order upon billing.
- D. Refer to Technology Drawings for detailed information relating to the appropriate alternates.

PART 2 PRODUCTS

2.01 MANUFACTURERS:

- A. The following material vendors are approved by the District for Structured Cabling System installation:
 - 1. Uniprise
 - 2. Systimax
 - 3. Panduit

2.02 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. 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, UL, or other applicable standards.
 - h. Otherwise as specified in Division 01, General Requirements.

2. 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.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:

1. Full and complete compliance with standards and guidelines set forth in this and subsequent specifications.
2. Field verify existing conditions prior to installation and make note of conflicts and discrepancies between these specifications and construction drawings to the Owner immediately.
 - a. Field discrepancies not noted to the Owner or Design Team prior to installation commencement the responsibility of the Contractor and repaired at no cost to the Owner.
3. Provide a complete and properly operating system for each item of equipment specified.
4. Install materials in a neat and professional manner.
5. Comply with equipment manufacturer's written instructions, the best industry practices, and the Contract Documents.

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. Remove and correct work installed without clarification 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. Coordinate route and installation where SMR is required with the Architect/Engineer prior to rough-in. Responsible for reinstalling SMR routed without such prior approval to the Architect's 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.

3.02 FIELD QUALITY CONTROL

A. Perform the following field inspections during installation and commissioning:

1. Visually inspect UTP and optical fiber jacket materials for NRTL certification markings.

2. Visually inspect cabling placements, pathways, and terminations in communications equipment rooms, telecommunications rooms, and work areas for compliance with standards and codes.
 3. Visually inspect grounding and bonding for compliance with standards and codes.
 4. Visually inspect installed cable trays, cable pathways, and wall penetrations for compliance with standards and codes.
- B. Responsible for field inspections and will submit a signed weekly inspection report to Owner.

3.03 INSTALLATION IN RATED CONSTRUCTION

- A. Install intumescent material around ducts, conduits, and other telecommunications 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 07, Thermal and Moisture Protection, 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 degrees F – 350 degrees F.
 3. An alternate method utilizing intumescent materials in caulk or putty complying with Division 07, Thermal and Moisture Protection may be used.

3.04 EQUIPMENT SUPPORT

- A. Minimum Support Capacity:
1. Provide fastening devices and supports for equipment, 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. Support 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.
- C. 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 one 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 sub-contractor installing the supports.
 3. Anchor conduit installed in poured concrete to the steel reinforcing with 14 AWG black iron wire.
- D. Powder actuated or similar shot-in fastening devices will not be permitted for technology work except by review from the project structural engineer.

3.05 ALIGNMENT

- A. Install panels, cabinets, and equipment level and plumb, parallel with structural building lines.

- B. Install equipment and enclosures fitted neatly, without gaps, openings, or distortion.
- C. Properly and neatly close 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.

3.06 CUTTING AND PATCHING

- A. General:
 - 1. Comply with Division 01, General Requirements.
 - 2. Restore to original condition new or existing work cut or damaged by installation, testing, and removal of 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 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 07 – Thermal and Moisture Protection.
- 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.

3.07 PROTECTION OF WORK

- A. Protect telecommunication work and equipment installed under this Division against damage by other trades, weather conditions, or other causes.
 - 1. Equipment found damaged or in other than new condition will be rejected as defective.
- B. Keep equipment, panels, outlets, and related telecommunication equipment covered or closed to exclude dust, dirt, and splashes of plaster, cement, paint, or other construction material spray.
 - 1. Equipment not free of 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.

3.08 PROJECT MANAGEMENT

- A. Designate a project manager to act as the single point of contact. Project manager to oversee work performed to ensure a quality installation compliant with specifications as outlined in documents (which includes specifications and drawings). Owner or Consulting Engineer will review a copy of the resume of the on-site project managers and each on-site team.
- B. Contractor project manager/supervisor to attend meetings arranged by General Contractor, Architect, Owner's representatives, and/or other parties affected by work of this specification.

3.09 DELIVERY AND STORAGE

- A. Assume custody and responsibility for the items upon delivery and determining that the contents are complete and in satisfactory condition for installation.

- B. Delivery, loss, storage, and protection: Materials and equipment delivered and placed in storage stored with protection from the weather, humidity, and temperature variation, dirt, and dust or other contaminants.
- C. Coordinate deliveries and submittals with the General Contractor/Owner to ensure a timely scheduled installation.
- D. Responsible for handling and control of cabling equipment and liable for material loss due to delivery and storage problems.
- E. No equipment or materials delivered to the job site more than three weeks prior to the commencement of its installation. Coordinate with General Contractor/Owner on location of storage materials.

3.10 CLEANING

- A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, dust, and construction debris and repair damaged finish, including chips, scratches, and abrasions. This includes touching up paint removed for grounding.
- B. Provide a clean work environment, free from trash/rubbish accumulated during and after cabling installation.
- C. Maintain construction materials and refuse within the area of work. Clean the work area at the end of each day.
- D. Keep liquids off finished floors, carpets, tiles, racks, and equipment. If liquid damages finishes or equipment, provide professional services to clean or repair scratched/soiled finishes or damaged equipment at the Contractors own expense.

3.11 PAINTING

- A. Certain Division 27 – Communications Sections contain the requirement of painting, it is the responsibility of the Contractor to coordinate the requirements and labor involved to complete this work with the General Contractor.
- B. Touch up marred and bared surfaces of primed, galvanized, and finish painted equipment, materials, and accessories installed.
- C. Restore patched surfaces as close to the original condition and finish as reasonably possible. Where patching occurs in smooth painted surface, extend final paint coat over entire unbroken surface containing patch, after patched area has received two coats of primer and two coats of finished paint.

3.12 COMPLETION AND TESTING

- A. General:
 - 1. Comply with Division 01, General Requirements.
- B. Upon completion, test systems to show that installed equipment operates as designed and specified, free of faults.
 - 1. Schedule system tests so that several occur on the same day.
 - 2. Coordinate testing schedule with construction phasing.
 - 3. Submit systems test reports for Design Team review and feedback.

4. Schedule proof-of-performance testing with Design Team representative and/or Owner's representative.
- C. A qualified contractor with required tools to conduct cable and equipment tests. Arrange to have the equipment factory representative present for those tests where the manufacturer's warranty could be impacted by the absence of a factory representative.
- D. Project Closeout:
 1. Manufacturer's Installation, Start-Up, and Adjustment Instructions.
 2. AS-BUILTS
 - a. Record copy and as-built drawings.
 - 1) Provide record copy drawings periodically throughout the project as requested by the General Contractor or Owner, and at end of the project on CD-ROM. Record copy drawings at the end of the project in AutoCAD format and include notations reflecting the as built conditions of additions to or variation from the drawings provided such as, but not limited to, cable paths and termination points. AutoCAD drawings are to incorporate test data imported from the test instruments.
 - 2) As built drawings include, but are not limited to: block diagrams, frame and cable labeling, cable termination points, equipment room layouts, rack elevations, and frame installation details. The as-built drawings includes field changes made up to construction completion:
 - a) Field directed changes to cross connect and patching schedule.
 - b) Horizontal cable routing changes.
 - c) Backbone cable routing or location changes, inclusive outside plant physical pathways (if within scope of this project).
 - d) Associated detail drawings.
 3. Operation and Maintenance Data.
 - a. Update to the Equipment/Product Data Submittals with identical document structure and digital document requirements.
 - b. Include digital copy in both of the following:
 - 1) Archival quality DVD-R
 - 2) USB flash drive
 - c. Include full manuals of equipment provided (data sheets alone not acceptable).
 - d. Include test data and reports.
 - e. Include original software configuration files and programming software for head-end equipment.
 - 1) Software files consist of both the original "un-compiled" file used for creating the system, as well as the compiled firmware/instructions that are loaded onto the head-end equipment/device. This includes, but is not limited to, the following typical systems:
 - a) Public Address

4. Special Warranty:
 - a. Do not offer a special warranty to Owner to supplement the standard warranty requirement covered in this Specification.
 - 1) With respect to the installation of Approved Manufacturer's Cabling System, furnish Approved Manufacturer's Cabling System application / system standard warranty.
- E. Perform tests per the requirements of each of the following systems:
 1. Horizontal data/voice structured cabling system.
 2. Backbone data/voice cabling system.
 3. Audio/video systems.
- F. Software and Programming
 1. Software, firmware, web-based GUI, and other systems with username and login credentials given unique passwords from the factory defaults.
 2. Maintaining factory default credentials is not acceptable.
 3. Document username/passwords for equipment in the as-built/O&M manuals.
- G. Provide a written record of final performance tests after final proof-of-performance review and acceptance, and submit with operation and maintenance data.

END OF SECTION

SECTION 27 05 26

GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section includes:
 - 1. Conductors
 - 2. Compression Lugs
 - 3. Taps
- B. Furnish and install grounding and bonding for communications systems, including labor, equipment, supplies, materials, and testing for a complete grounding (earthing) and bonding system.

1.02 RELATED SECTIONS

- A. Division 01, General Requirements
- B. Division 27, Communications
- C. Section 27 05 00, Common Work Results for Communications
- D. Section 26 05 26, Grounding and Bonding for Electrical Systems

1.03 REFERENCES

- A. References, Codes and Standards as required by Section 27 05 00, Common Work Results for Communications and Division 01, General Requirements.
- B. In addition, meet the following:
 - 1. ANSI/NECA/BICSI-607-2011 Telecommunications Bonding and Grounding Planning and Installation. Methods for Commercial Buildings.
 - 2. UL 467 Standard for Grounding and Bonding Equipment.

1.04 QUALITY ASSURANCE

- A. Conform to the quality assurance requirements of Section 27 05 00, Common Work Results for Communications and Division 01 – General Requirements.

1.05 SUBMITTALS

- A. Including, but not limited to: Product Data Sheets, Shop Drawings, etc.
- B. General:
 - 1. Submit in accordance with Section 27 05 00, Common Work Results for Communications submittal requirements.
- C. Closeout Submittals:
 - 1. Submit in accordance with Section 27 05 00, Common Work Results for Communications submittal requirements.

1.06 DEFINITIONS

- A. Backbone: A facility (e.g., pathway, cable, or conductors) between telecommunications rooms or floor distribution terminals, entrance facilities, and equipment rooms within or between buildings.
- B. Bonding: The permanent joining of metallic parts to form an electrically conductive path that will assure electrical continuity and the capacity to conduct safely current likely to be imposed.
- C. Common Bonding Network (CBN):
 - 1. The principal means for effecting bonding and grounding inside a telecommunication building.
 - 2. It is the set of metallic components that are intentionally or incidentally interconnected to form the principal bonding network (BN) in a building.
 - 3. These components include structural steel or reinforcing rods, plumbing, alternating current (AC) power conduit, AC equipment grounding conductors (ACEGs), cable racks, and bonding conductors.
 - 4. CBN always has a mesh topology and is connected to the grounding electrode system.
- D. EMI (Electromagnetic Interference): The interference in signal transmission or reception resulting from the radiation of electrical or magnetic fields.
- E. Entrance Facility (telecommunications): An entrance to a building for both public and private network service cables (including antennae) including the entrance point at the building wall and continuing to the entrance room or space.
- F. Equipment Room (telecommunications):
 - 1. A centralized space for telecommunications equipment that serves the occupants of the building.
 - 2. An equipment room is considered distinct from a telecommunications room because of the nature or complexity of the equipment.
- G. Exothermic Weld: A method of permanently bonding two metals together by a controlled heat reaction resulting in a molecular bond.
- H. Ground: A conducting connection, whether intentional or incidental, between an electrical circuit or equipment and the earth or to some conducting body that serves in place of the earth.
- I. Telecommunications Bonding Conductor (TBC): The conductor used to connect the grounding electrode to the equipment grounding conductor, to the grounded conductor, or both of the circuits at the service equipment, or at the source of a separately derived system.
- J. Mesh Bonding Network (Mesh-BN): A bonding network to which associated equipment (e.g., cabinets, frames, racks, trays, pathways) are connected using a bonding grid, which is connected to multiple points on the common bonding network.
- K. Primary Bonding Busbar (PBB): A busbar placed in a convenient and accessible location and bonded, by means of the telecommunications bonding conductor (TBC), to the building service equipment (power) ground.

- L. Primary Protector: A surge protective device placed on telecommunications entrance conductors in accordance with ANSI/NFPA 70 and ANSI/ATIS 0600318 and listed under ANSI/UL 497.
- M. Rack Bonding Conductor (RBC): A bonding conductor used to connect the rack/cabinet directly to the PBB/SBB/Mesh
- N. Rack Bonding Busbar (RBB)
- O. Secondary Bonding Busbar (SBB):
 - 1. The interface to the building telecommunications bonding system generally located in a telecommunications room.
 - 2. A common point of connection for telecommunications system and equipment bonding to ground and located in the telecommunications room or equipment room.
- P. Telecommunications Room (TR): An enclosed space for housing telecommunications equipment, cable terminations, and cross-connect cabling, that is the recognized location of the cross-connect between the backbone and the horizontal facilities.
- Q. Telecommunications Bonding Backbone (TBB): A conductor that interconnects the primary bonding busbar (PBB) to the secondary bonding busbar (SBB).
- R. Backbone Bonding Conductor (BBC):
 - 1. When there are multiple TBBs, the BBC is employed to interconnect them through the associated busbars, either on the same floor in a multi-story building or in the same general area of a single story building.
 - 2. Referred to as a Grounding Equalizer (GE).
- S. Telecommunications Equipment Bonding Conductor (TEBC): A conductor that connects the primary bonding busbar (PBB) or secondary bonding busbar (SBB) to equipment racks or cabinets.
- T. Unit Bonding Conductor (UBC): A bonding conductor used to connect rack/cabinet mounted equipment unit to the grounding structure (i.e., conductor, busbar) utilized in that rack/cabinet.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Conductors:
 - 1. Cooper B-Line
 - 2. Erico
 - 3. Panduit
 - 4. Or approved equal.
- B. Compression Lugs:
 - 1. Cooper B-Line
 - 2. Panduit
 - 3. Thomas & Betts

- 4. Or approved equal.
- C. Taps:
 - 1. Thomas & Betts
 - 2. Burndy
 - 3. Or approved equal.

2.02 CONDUCTORS

- A. The telecommunications backbone insulated copper conductor.
- B. Rated to meet installed environment. Bare copper is not permitted for use in communications installations.
- C. Jumpers: Compression ring terminal at both ends.
- D. Size cables per table in PART 3.

2.03 COMPRESSION LUGS

- A. Grounding conductor terminations (lugs) listed compression type, two-hole, long barrel with window lug with a minimum of two crimps. Crimp according to manufacturer's recommendation.
- B. UL and CSA listed
- C. Able to accept 6 AWG to 3/0 AWG.
- D. Compression type
- E. Two holes with various hole spacings to fit the busbar.
- F. Long barrel that will allow a minimum of two crimps with standard industry colors.
- G. An inspection window to verify that the conductor is fully seated in the lug.
- H. Have a traceable feature to ensure proper die size was used to make the crimp.
- I. Crimped according to manufacturer's recommendation.

2.04 TAPS

- A. Connections made with irreversible compression connectors.
- B. UL and CSA listed
- C. Able to accept 6 AWG to 3/0 AWG.
- D. Have a traceable feature to ensure proper die size was used to make the crimp.
- E. Requires a minimum of two crimps for C Tap and H Tap, 1 crimp for I-Beam and busbar Tap.
- F. Crimp according to manufacturer's recommendation.

PART 3 EXECUTION

3.01 PRIMARY BONDING BUSBAR (PBB)

- A. Attachments to existing PBB:
 - 1. New Cable Tray
 - 2. New 2-post racks

3.02 SECONDARY BONDING BUSBAR (SBB)

A. Attachments to existing SBB:

1. New Cable Tray
2. New 2-post racks

3.03 TELECOMMUNICATIONS EQUIPMENT BONDING CONDUCTOR (TEBC)

- A. Connects the PBB/SBB to equipment racks/cabinets.
- B. Continuous copper conductor that should be sized per the length of cable.
- C. Separate from ferrous materials by 2-inches or be bonded to the ferrous metal.
- D. Route within cable trays or suspended 2-inches under or off the side of the cable tray or ladder rack.
- E. Support every 3-feet.
- F. 8-inch Bend radius with no less than a 90 degree bend.
- G. May come in contact with other cable groups at a 90 degree angle only.
- H. Cable shields do not satisfy the requirement.
- I. There may be more than one TEBC within each telecommunication room.

3.04 RACK BONDING CONDUCTOR (RBC)

- A. Use a bonding conductor to connect the rack/cabinet directly to the PBB/SBB.
- B. Bond metallic enclosures, including telecommunications cabinets and rack to the SBB, or PBB using a minimum sized conductor of 6 AWG.
- C. Do not bond serially cabinets, racks, and other enclosures in computer rooms; each to have their own dedicated bonding conductor to the SBB, or PBB.

3.05 CABLE TRAY

- A. To achieve the objective of potential equalization in the TR, cable runway sections are bonded together and bonded back to the PBB/SBB.
- B. Maintain an 8-inch Bend Radius on the TEBC.
- C. Keep a 2-inch separation from other cables, power, and telecommunications.
- D. Remove paint, oxidation, etc., from the runway surfaces that are being bonded.
- E. Drill two holes as required to accommodate the two-hole compression lug.
- F. Apply a thin coat of antioxidant around the holes and on the surface where the lug will be in contact.
- G. Attach straps to the runway using stainless steel hardware sized for the lug holes.
- H. Tighten the hardware.
- I. Wipe off excess antioxidant after installation of the lug.

3.06 LABELING

- A. The format for the telecommunications main grounding busbar, TR-PBB, while the format for the SBBs, TR-SBB.
 - 1. TR identifier is the room number for the space containing the busbar.
 - 2. PBB is the portion of an identifier designating a telecommunications main grounding busbar.
 - 3. SBB is the portion of the identifier designating a telecommunications grounding busbar.
- B. Assign each telecommunications space or room an identifier unique within the building. Label TS with the TS identifier inside the room so as to be visible to someone working in that room. Use the FS format for the TS identifier.
- C. Label should be visible and legible.

3.07 TESTING

- A. Earth Ground Resistance Tester:
 - 1. The earth ground resistance tester generates a specific test current, this current is less susceptible to the influences of stray currents on the grounding system.
 - 2. This makes the ground resistance tester a more accurate testing device than a standard Volt-Ohm-multimeter.
- B. Two-point ground continuity testing: Maximum value 100 milliohms.
- C. Follow manufacturer's instructions on setup and how to perform the test.
- D. Care should be taken and safety precautions in place.

END OF SECTION

SECTION 27 05 28
PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

- A. Furnish and install conduit and cable tray for accessibility to new devices.
 - 1. Conduit pathway shall be provided for horizontal cabling routed in inaccessible spaces including walls, floors, and ceilings.
- B. This Section includes:
 - 1. Conduit and other Closed Pathway System
 - 2. Wide Base Cable Supports
 - 3. Device Backboxes
 - 4. Enclosures and Pullboxes
 - 5. Cable Straps
 - 6. Surface Mounted Raceway
- C. Work covered by this Section consists of furnishing labor, equipment, supplies, materials, and testing unless otherwise specified for a complete pathways system for the communications systems.

1.02 RELATED SECTIONS

- A. Division 01, General Requirements
- B. Division 27, Communications
- C. Section 27 05 00, Common Work Results for Communications
- D. Section 26 05 33, Raceways and Boxes for Electrical Systems
- E. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01, General Requirements Specification Sections, apply to this Section.
- F. Provisions of Division 27 Communications Section 27 05 00, Common Work Results for Communications, apply to this Section.

1.03 REFERENCES

- A. References, Codes and Standards as required by Section 27 05 00, Common Work Results for Communications and Division 01, General Requirements.
- B. In addition, meet the following:
 - 1. Underwriters Laboratories, Inc.:
 - a. UL 1-03 Flexible Metal Conduit
 - b. UL 5-01 Surface Metal Raceway and Fittings
 - c. UL 6-03 Rigid Metal Conduit
 - d. UL 50-03 Enclosures for Electrical Equipment
 - e. UL 360-03 Liquid-Tight Flexible Steel Conduit

- f. UL 467-01 Grounding and Bonding Equipment
- g. UL 514A-01 Metallic Outlet Boxes
- h. UL 514B-02 Fittings for Cable and Conduit
- i. UL 514C-05 Nonmetallic Outlet Boxes, Flush-Device Boxes and Covers
- j. UL 651-02 Schedule 40 and 80 Rigid PVC Conduit
- k. UL 651A-03 Type EB and A Rigid PVC Conduit and HDPE Conduit
- l. UL 797-03 Electrical Metallic Tubing
- m. UL 1242-00 Intermediate Metal Conduit
- n. UL 1684 Fiberglass Conduit Above Ground
- 2. National Electrical Manufacturers Association:
 - a. NEMA TC-3-04 PVC Fittings for Use with Rigid PVC Conduit and Tubing
 - b. NEMA FB1-03 Fittings, Cast Metal Boxes and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable

1.04 QUALITY ASSURANCE

- A. Conform to the quality assurance requirements of Section 27 05 00 – Common Work Results for Communications and Division 01 – General Requirements.3
- B. Low voltage system cable supports and accessories listed to Underwriter's Laboratories or other national recognized testing laboratory.
- C. Low voltage system cable supports and accessories have the manufacturers name and part number stamped on the part for identification.
- D. Pre-Installation Meetings:
 - 1. Setup a pre-installation meeting to discuss low voltage cable support layout work and installation guidelines.
 - 2. Organize meeting a minimum of 30 days prior to initiating cable support installation work.
 - 3. Attendees include Contractor, appropriate subcontractors, low voltage system vendors, Architect, and Owner's Representative.
- E. Purpose of meeting is to coordinate work between the parties to have a consistent layout for low voltage system cables, minimize interferences, and to make cable system accessibility for future owner modifications and maintenance high priority issue for installers.

1.05 SUBMITTALS

- A. Including, but not limited to: Product Data Sheets, Shop Drawings, etc.
- B. General:
 - 1. Submit in accordance with Section 270500 – Common Work Results for Communications submittal requirements.
- C. Closeout Submittals:
 - 1. Submit in accordance with Section 270500 – Common Work Results for Communications submittal requirements.

D. Additional requirements specific to this Section:

1. Firestop design basis documentation that includes 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.

1.06 COORDINATION

- A. Responsible for coordinating the arrangement, mounting and support for communications support equipment.
- B. In accordance with the requirements set forth in Section 27 05 00 – Common Work Results for Communications, provide the following:
 1. Plan view and elevations of raceways (conduits, cable trays, ladder racks, floor ducts, junction boxes, pull boxes, splice boxes, manholes, and associated supports).
 - a. Vertical and horizontal offsets and transitions.
 - b. Clearances for access above and to side of cable trays.
 - c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
- C. Coordinate layout and installation of low voltage cable bundle supports with other construction elements to ensure adequate headroom, working clearance and access. Revise locations and elevations for those indicated as required to suit field conditions and as approved by Owner's Representative.
- D. Examine drawings and existing conditions above ceilings and include additional supports in bid price to avoid ducts, pipes, conduits, etc. Installation in existing ceilings can be very difficult. Include extra labor time involved in bid price.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Conduit and Other Closed Pathways Systems:
 1. Conduit:
 - a. Allied
 - b. Prime
 - c. Wheatland
 - d. Or approved equal.
 2. Conduit Supports:
 - a. Allied
 - b. Prime
 - c. Wheatland
 - d. Or approved equal.
- B. Wide Base Cable Supports:
 1. ERICO Caddy CableCat Series

2. Garvin
 3. ICC
 4. Or approved equal.
- C. Device Backboxes:
1. Raco
 2. Steel City
 3. Bowers
 4. Or approved equal.
- D. Enclosures and Pullboxes:
- a. Hoffman
 - b. Cooper B-Line
 - c. Or approved equal.
- E. Cable Straps:
1. Panduit
 2. Velcro
 3. Or approved equal.

2.02 CONDUIT AND OTHER CLOSED PATHWAY SYSTEMS

- A. Conduit Size: In accordance with the NEC, but not less than 1-inch unless otherwise shown in the Contract Drawings.
- B. Install in accordance with the construction documents, national codes, and applicable publications designated herein.
- C. Conduit:
1. Following construction types:
 - a. Electrical Metallic Tubing
 - b. Rigid Galvanized Steel
 - c. Flexible Non-Metallic Conduit.
 - d. Install as recommended by the raceway manufacturer and construction documents.
 - e. Flexible Metallic Conduit is not permitted in this project for interior installation.
- D. Conduit Supports:
1. Individual Conduit Hangers: Designed for the purpose, having a preassembled closure bolt and nut, and provisions for receiving a hanger rod.
 2. Install conduit supports at a maximum of 5-foot centers.

2.03 WIDE BASE CABLE SUPPORTS

- A. Wide base J-hooks complying with most current revision of the TIA 568 and 569 structured cabling system requirements.

- B. Minimum size is 1-5/16-inch diameter loop for 50, 4-pair UTP or 2 strand fiber optic cable or inner duct. Provide larger size or multiple hooks where required.
- C. Minimum 1-inch width and flared edges where cables enter and leave support.
 - 1. 1.3-inch diameter loop for maximum 35, 4-pair UTP
 - 2. 2-inch diameter loop for maximum 50, 4-pair UTP
- D. Accessories:
 - 1. Provide applicable accessories to independently support J-hooks from structure.
 - 2. Include extender bracket for mounting multiple J-hooks on a single support, fasteners, and clamps for connecting to wall, beams, rods, dedicated support wires and C and Z Purlins as required for specific construction.
- E. Cable Retainers: Provide cable retainers at each J-hook.
- F. Refer to cable bundling instructions specified herein.
- G. Finish:
 - 1. Dry Locations, Above Lay-in Ceiling, Below Raised Floor – galvanized.
 - 2. Wet and Damp Locations: stainless steel.

2.04 DEVICE BACKBOXES

- A. Flush mounted, sheet steel construction with conduit knockout.
- B. UL514A Listed
- C. Unless otherwise noted, provide:
 - 1. 4-inch square, 2-5/8-inch deep backbox Code minimum rated for the installed application.
- D. Gang mud rings sizes as required for the applicable device.

2.05 ENCLOSURES AND PULLBOXES

- A. Pull Boxes:
 - 1. Provide enclosure and pull boxes as shown in the construction documents.
 - 2. Measure and provide additional conduit offsets required by Contractor not shown in Drawings with properly sized pull boxes.
 - 3. Pull Box Sizing:

Minimum Trade Size Conduit	Width	Length	Depth	Each Additional Conduit Increase (Width)
3/4-inch	4-inch	12-inch	3-inch	2-inch
1-inch	4-inch	16-inch	3-inch	2-inch
1-1/4-inch	6-inch	20-inch	3-inch	3-inch
1-1/2-inch	8-inch	27-inch	4-inch	4-inch
2-inch	8-inch	36-inch	4-inch	5-inch
2-1/2-inch	10-inch	42-inch	5-inch	6-inch
3-inch	12-inch	48-inch	5-inch	8-inch
3-1/2-inch	12-inch	54-inch	6-inch	6-inch
4-inch	15-inch	60-inch	8-inch	8-inch

2.06 CABLE STRAPS

- A. Use within telecommunications rooms and open cable pathways (cable tray). Provide for strapping groups of cables to raceway and for controlling/managing patch cables.
- B. The use of plastic tie wraps for this purpose is not acceptable.
 - 1. Self-gripping, reusable, constructed of Velcro, and hook-and-loop style.
 - 2. Plenum rated cable straps to be used in plenum air handling spaces.
- C. Quantity:
 - 1. Provide in sufficient quantity to strap cable bundles at intervals specific to the type of cable bundle. For the purposes of determining the quantity of straps to provide, the number of cables in a cable bundle and the intervals at which straps applied are as follows:
 - a. Bundle size (use to determine strap quantity):
 - 1) For Patch Cables: Maximum of 25 patch cables per cable bundle with straps applied at 1-foot intervals.
 - 2) For horizontal cabling: Maximum of 25 station cables per cable bundle with straps applied at 3-foot intervals.
 - 3) For Backbone Cables: Maximum of 4 backbone cables per cable bundle with straps applied at 3-foot intervals.
- D. Bundling (use to determine strap quantity):
 - 1. Bundle cables by application (patch, horizontal, backbone) and by cable type (Category X, MM Fiber, SM Fiber, etc.).
 - 2. Do not intermix cable applications and types within a bundle.
- E. Color: Black

2.07 SURFACE MOUNTED RACEWAY (SMR)

- A. SMR refers to a system used for routing network cabling to outlets on existing solid walls or walls with fire-blocking. SMRs may be omitted where access into existing walls is available.
- B. Panduit TG-70, or approved equivalent.
- C. Horizontal SMR in lab environment shall be installed below the work surface height of computer tables.
- D. UL listed and approved for the intended applications by the local authorities having jurisdiction. Size to accommodate initial cable requirements plus a 50 percent expansion without exceeding the current NEC fill ratio requirements.
- E. Provide with all fittings including mounting clips and straps, couplings, flat, bend limiting internal and external elbows, cover clips, bushings, device boxes, and other incidental and miscellaneous hardware required. Fittings/bends shall be sized to accommodate CAT 6 and fiber optic bend radii as specified in ANSI/TIA/568-C series. SMR finish shall match, as close as possible, the finish of the wall it is to be mounted on.
- F. Do not install through walls.
- G. Securely support in accordance with manufacturer's installation instructions.

PART 3 EXECUTION

3.01 CONDUIT INSTALLATION

A. Conduits:

1. Cables installed in under slab conduits shall be manufactured with jackets rated for damp or wet applications and employ proper moisture blocking techniques in construction.
2. Conduits to Data Outlets shall be a minimum of 1-inch diameter. Conduit pathways and sleeves shall be EMT conduit. All conduits shall have appropriate bushings installed on the ends prior to cabling being pulled. In case EMT conduit cannot be used, 1½ flexible metallic conduit may be used. Nylon pull strings shall be used in all conduit sleeves and pathways. Runs shall be less than 90 meters in length and contain no more than two 90° bends. Conduit shall be sized to accommodate initial cable requirements plus a 50 percent expansion without exceeding the current NEC fill ratio requirements.
3. Support independently of the ceiling support system.
4. Conduit sleeves that protrude through a floor terminates 3-inches to 6-inches above the surface of the floor. Conduits that exit the Equipment Penthouse rooms shall be extended to the Cable Tray, and be bonded to the SBB/PBB.
5. Provide separate conduits/sleeves/j-hooks for different Division 27/28 systems.

B. Penetrations: Cutting or Holes:

1. Locate holes in advance where they are proposed in the structural sections such as ribs or beams. Obtain the approval of the structural engineer prior to drilling through structural sections.
2. Cut holes through concrete and masonry in new and existing structures with a diamond core drill or concrete saw. Pneumatic hammer, impact electric, hand or manual hammer type drills are not allowed, except where permitted by the Owner's Information Technology as required by limited working space.

C. Fire Stopping:

1. Where conduits, wire ways, and other communications raceways pass through fire partitions, fire walls, smoke partitions, or floors, install a fire stop that provides an effective barrier against the spread of fire, smoke, and gases as specified in Division 07, Thermal and Moisture Protection , with rock wool fiber or silicone foam sealant only.
2. Completely fill and seal clearances between raceways and openings with the fire stop material.
3. All penetrations through fire-rated building structures (walls and floors) shall be sealed with an appropriate fire stop system. This requirement applies to through penetrations (complete penetration) and membrane penetrations (through one side of a hollow fire rated structure).
4. Label all firewall penetrations as indicated on the As-Built Drawings. Any penetrations left unused shall be sealed.

- D. Waterproofing: At floor, exterior wall, and roof conduit penetrations, completely seal clearances around the conduit and make watertight as specified in Division 07, Thermal and Moisture Protection.

3.02 INSTALLATION, GENERAL

A. Install conduit as follows:

1. In complete runs before pulling in cables or wires.
2. Flattened, dented, or deformed conduit is not permitted. Remove and replace the damaged conduits with new undamaged material.
3. Assure conduit installation does not encroach into the ceiling height headroom, walkways, or doorways.
4. Cut square with a hacksaw, ream, remove burrs, and draw up tight.
5. Mechanically continuous.
6. Independently support conduit at 5-feet on center. No other supports allowed.
7. Support within 1-foot of changes of direction, and within 1-foot of each enclosure to which connected.
8. Close ends of empty conduit with plugs or caps at the rough-in stage to prevent entry of debris, until wires are pulled in.
9. Conduit installations under fume and vent hoods are prohibited.
10. Secure conduits to cabinets, junction boxes, pull boxes, and outlet boxes with bonding type locknuts. Do not use aluminum conduits in wet locations.
11. Unless otherwise indicated on the drawings or specified herein, install conduits concealed within finished walls, floors, and ceilings.

B. Conduit Bends:

1. Device to control the bend radius must comply with National Electrical Code requirements and TIA Standards. In addition, the product must be RoHS compliant to meet environmental requirements, UL 94V-0 approved to reduce the spread of flame, and be approved by UL for use in air handling spaces.
2. UL Listed

C. Provide at horizontal 4-inch conduits.

D. Provide at cable tray above equipment racks.

1. Make bends only with manufacturer approved tools or fittings.
2. Do not use standard conduit bending machines.
3. Conduit hickey benders may be used for slight offsets, and for straightening stubbed out conduits.
4. Bending of conduits with a pipe tee or vise is prohibited.

E. Layout and Homeruns:

1. Deviations: Make only where necessary to avoid interferences and only after Drawings showing the proposed deviations have been submitted approved by the Owner Information Technology Team.

3.03 CONCEALED WORK INSTALLATION

A. In Concrete:

1. Conduit: Rigid steel, IMC or EMT. Do not install EMT in concrete slabs that are in contact with soil, gravel, or vapor barriers.
2. Align and run conduit in direct lines.
3. Install conduit through concrete beams only when the following occurs:
 - a. Where shown on the Structural Drawings.
 - b. As approved by the Designer prior to construction, and after submittal of Drawing showing location, size, and position of each penetration.
4. Installation of conduit in concrete that is less than 3-inches thick is prohibited.
 - a. Conduit outside diameter larger than 1/4 of the slab thickness is prohibited.
 - b. Space between conduits in slabs: Approximately six conduit diameters apart, except one conduit diameter at conduit crossings.
 - c. Install conduits approximately in the center of the slab so that there will be a minimum of 3/4-inch of concrete around the conduits.
5. Conduit for conductors 600V and below:
 - a. Different type conduits mixed indiscriminately in the same system is prohibited.
6. Align and run conduit parallel or perpendicular to the building lines.
7. Connect recessed lighting fixtures to conduit runs with maximum 6 feet) of flexible metal conduit extending from a junction box to the fixture.
8. Tightening set screws with pliers is prohibited.

3.04 EXPOSED WORK INSTALLATION

- A. The path Surface Mounted Raceway shall be selected to minimize impact on existing molding, tack boards, and other architectural elements. Vertical runs of raceway from the ceiling to outlets shall be installed on walls near corners wherever possible. Raceway may be installed horizontally at the same height as the outlets or near to the ceiling. Entrance end fittings will be supplied at the ends of raceway runs to transition to conduit sleeves through walls, ceilings, or floors.
- B. Unless otherwise indicated on the Drawings, exposed conduit is only permitted in mechanical and electrical rooms.
- C. Conduit for Conductors 600V and below: Different type of conduits mixed indiscriminately in the system is prohibited.
- D. Align and run conduit parallel or perpendicular to the building lines.
- E. Install horizontal runs close to the ceiling or beams and secure with conduit straps.

- F. Support horizontal or vertical runs at not over 8-foot) intervals.
- G. Surface Metal Raceways:
 - 1. Use only where shown.
- H. Painting:
 - 1. Paint exposed conduit as specified in Division 09, Finishes.
 - 2. Paint conduits containing cables rated over 600V safety orange.
 - 3. Refer to Division 09, Finishes for preparation, paint type, and exact color.
 - 4. Paint legends, using 2-inch high black numerals and letters, showing the cable voltage rating.
 - 5. Provide legends where conduits pass through walls and floors and at maximum 20-foot intervals in between.

3.05 EXPANSION JOINTS

- A. Conduits 3-inches and larger secured to the building structure on opposite sides of a building expansion joint, require expansion and deflection couplings. Install the couplings in accordance with the manufacturer's recommendations.
- B. Provide conduits smaller than 3-inches with junction boxes on both sides of the expansion joint. Connect conduits to junction boxes with sufficient slack of flexible non-metallic conduit to produce 5-inch vertical drop midway between the ends.
- C. Install expansion and deflection couplings where shown.
- D. Seismic Areas:
 - 1. In seismic areas, provide conduits rigidly secured to the building structure on opposite sides of a building expansion joint with junction boxes on both sides of the joint.
 - 2. Connect conduits to junction boxes with 15-inches of slack flexible conduit.
 - 3. Flexible Conduit: Copper green ground bonding jumper installed.

3.06 CONDUIT SUPPORTS, INSTALLATION

- A. Safe working load not to exceed 1/4 of proof test load of fastening devices.
- B. Use pipe straps or individual conduit hangers for supporting individual conduits. Maximum distance between supports is 8-foot on center.
- C. Support multiple conduit runs with trapeze hangers. Use trapeze hangers that are designed to support a load equal to or greater than the sum of the weights of the conduits, wires, hanger itself, and 200 pounds. Attach each conduit with U-bolts or other approved fasteners.
- D. Support conduit independently of junction boxes, pull boxes, fixtures, suspended ceiling T-bars, angle supports, and similar items.
- E. Fasteners and Supports in Solid Masonry and Concrete:
 - 1. New Construction: Use steel or malleable iron concrete inserts set in place prior to placing the concrete.

- 2. Existing Construction:
 - a. Steel expansion anchors not less than 1/4-inch bolt size and not less than 1-1/8-inch embedment.
 - b. Power set fasteners not less than 1/4-inch diameter with depth of penetration not less than 3-inches.
 - c. Use vibration and shock resistant anchors and fasteners for attaching to concrete ceilings.
- F. Hollow Masonry:
 - 1. Toggle bolts are permitted.
- G. Bolts supported only by plaster or gypsum wallboard are not acceptable.
- H. Metal Structures: Use machine screw fasteners or other devices specifically designed and approved for the application.
- I. Attachment by wood plugs, raw plug, plastic, lead or soft metal anchors, or wood blocking and bolts supported only by plaster is prohibited.
- J. Do not use chain, wire, or perforated strap to support or fasten conduit.
- K. Spring steel type supports or fasteners are prohibited for uses except: horizontal and vertical supports/fasteners within walls.
- L. Vertical Supports:
 - 1. Vertical Conduit:
 - a. Riser clamps and supports in accordance with the NEC and as shown.
 - 2. Provide supports for cable and wire with fittings that include internal wedges and retaining collars.

3.07 BOX INSTALLATION

- A. Boxes for Concealed Conduits:
 - 1. Flush mounted.
 - 2. Provide raised covers for boxes to suit the wall or ceiling, construction, and finish.
- B. Install additional boxes where needed to prevent damage to cables and wires during pulling in operations.
- C. Remove only knockouts as required and plug unused openings. Use threaded plugs for cast metal boxes and snap-in metal covers for sheet metal boxes.

3.08 COMMUNICATION SYSTEM CONDUIT

- A. Minimum conduit size of 1-inch, but not less than the size shown on the Drawings.
- B. Equip conduit ends with insulated bushings.
- C. 4-inch conduits within buildings include pull boxes after every two 90 degree bends. Size boxes per the NEC.
- D. Vertical conduits/sleeves through closets floors terminate not less than 3-inches below the floor and not less than 12-inches) below the ceiling of the floor below.

- E. Terminate conduit runs to/from a backboard in a closet or interstitial space at the top or bottom of the backboard. Conduits enter communication closets next to the wall and be flush with the backboard.
- F. Where drilling is necessary for vertical conduits, locate holes so as not to affect structural sections such as ribs or beams.
- G. Seal empty conduits located in communication closets or on backboards with a standard non-hardening duct seal compound to prevent the entrance of moisture and gases and to meet fire resistance requirements.
 - 1. Conduit runs contain no more than 2 quarter turns (90 degree bends) between pull boxes/backboards. Minimum radius of communication conduit bends as follows (special long radius):

Sizes of Conduit Trade Size	Radius of Conduit Bends
3/4	6-inches
1	6-inch
1-1/4	7-1/5-inch
1-1/2	9-inch
2	12-inch
2-1/2	25-inch
3	30-inch
3-1/2	36-inch
4	40-inch

3.09 CABLE INSTALLATION

- A. Install cables only when each cable tray run has been completed and inspected.
- B. Fasten cables on vertical runs to cable trays every 18 inches, using specified Velcro cable straps. Plastic wire-ties are not permitted for communications use.
- C. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure no more than 72-inches.
- D. Pathway cabling fill to not exceed a maximum of 40 percent, or per manufacturer's recommendations. Provide multiple support and pathway systems where required cable count exceeds 40 percent fill.
- E. Unless otherwise noted, group cabling in separate supports and pathways by the following systems:
 - 1. Voice and Data, Intercom and IP Video Surveillance Systems
 - 2. Analog Video Surveillance and SMATV/CATV Systems
 - 3. Access Control and Intrusion Systems
 - 4. Audio-Visual Systems
 - 5. Distributed Antenna Systems

6. Building Automation Systems
7. Lighting Control Systems
8. Motorized Shade Systems
9. Fire Alarm Systems

3.10 CONNECTIONS

- A. Connect pathways to cable trays according to requirements in NEMA VE 2-2000 and NEMA FG 1-1993 where applicable.

3.11 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections, with the assistance of a factory-authorized service representative if necessary:
 1. After installing cable trays and after cabling has been energized, survey for compliance with requirements.
 2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.
 3. Verify that the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications or data-processing circuits are separated from power circuits by physical barriers or are installed in separate cable trays. Barriers are required between different voltage types.
 4. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.
 5. Remove dust deposits, industrial process materials, trash of description, and blockage of tray ventilation.
 6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and re-torque in suspect areas.
 7. Check for improperly sized or installed bonding jumpers.
 8. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
 9. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 Ohm.
- B. Provide test and inspection reports.

3.12 PROTECTION

- A. Protect installed cable trays and cables.
 1. Install temporary protection for cables in open trays to safeguard exposed cables against falling objects or debris during construction.
 2. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.

3. Repair damage to paint finishes with matching touchup coating recommended by cable tray manufacturer.

END OF SECTION

SECTION 27 15 00
COMMUNICATIONS HORIZONTAL CABLING

PART 1 GENERAL

1.01 SUMMARY

- A. This Section includes:
 - 1. Manufacturers
 - 2. Horizontal Cable
 - 3. Work Area Outlet Jacks
 - 4. Faceplates
 - 5. Wall Phone Wall Jack Assembly
 - 6. Equipment/Patch Cables
- B. Wireless Access Point (WAP)
 - 1. The District has standardized on an Aruba enterprise wireless solution. Data jack will consist of a dual CAT 6a-plenum cable to each WAP. WAP will be interconnected at each MDF/IDF to a District provided/installed PoE switch.
- C. Conduits
 - 1. Conduit pathway shall be provided for horizontal cabling routed in inaccessible spaces including walls, floors, and ceilings.
- D. Wireless Access Point outlets
 - 1. Two Category 6a cables shall be installed from the serving IDF to each WAP location. A 10'-0" service loop shall be coiled in the ceiling space above the WAP without exceeding the manufacturer's bend radius.
- E. All non-WAP outlets shall be cabled with Category 6 cabling.
- F. Labeling
 - 1. All Data Outlets shall be labeled in accordance with BSD labeling standard for data drops.

1.02 RELATED SECTIONS

- A. Division 01, General Requirements
- B. Division 27, Communications
- C. Section 27 05 00, Common Work Results for Communications
- D. Division 28, Safety and Security

1.03 REFERENCES

- A. References, Codes and Standards as required by Section 27 05 00, Common Work Results for Communications and Division 01, General Requirements.
- B. In addition, meet the following:
 - 1. ANSI/TIA/EIA - 568-B Commercial Building Telecommunications Cabling Standard

2. ANSI/TIA/EIA - 569-A Commercial Building Standard for Telecommunications Pathway and Spaces
3. EIA/TIA-606-A Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
4. EIA/TIA-607 Commercial Building Grounding and Bonding requirements for Telecommunications
5. NEMA - 250
6. Federal Communications Commission 47 CFR 68.
7. BICSI Telecommunications Distribution Design Manual
8. BICSI Telecommunications Cabling Installation Manual
9. ANSI/NECA/BICSI 568-2001 Standard for Installing Commercial Building Telecommunications Cabling
10. ADA - Americans with Disabilities Act
11. NFPA 70 - 2002, including:
 - a. NEC - Article 770
 - b. NEC - Article 800
12. Underwriters Laboratory

1.04 QUALITY ASSURANCE

- A. Conform to the quality assurance requirements of Section 27 05 00 – Common Work Results for Communications and Division 01 – General Requirements.
- B. Install cabling and connectivity components in a neat and workmanlike manner. Methods of construction that are not specifically described or indicated in the Contract Documents and subject to the control and approval of the owner's Information technology Department.
- C. Equipment and materials quality and manufacture indicated. Equipment specified is based upon the manufacturers listed.
- D. Equipment new and free of defects.
- E. Strictly adhere to Telecommunications Industry Alliance standard installation practices when installing UTP data cabling.
- F. Materials and work specified herein comply with the most current version of the publications listed in the References section of this document.

1.05 SUBMITTALS

- A. Including, but not limited to: Product Data Sheets, Shop Drawings, etc.
- B. General:
 1. Submit in accordance with Section 27 05 00 – Common Work Results for Communications submittal requirements.
- C. Closeout Submittals:
 1. Submit in accordance with Section 27 05 00 – Common Work Results for Communications submittal requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Horizontal Cable:
 - 1. Approved cable partner of Commscope or Panduit.
- B. Work Area Outlet Jacks:
 - 1. Commscope (Uniprise or Systimax)
 - 2. Panduit
- C. Faceplates:
 - 1. Commscope (Uniprise or Systimax)
 - 2. Panduit
- D. Equipment/Patch Cables:
 - 1. Commscope (Uniprise or Systimax)
 - 2. Panduit

2.02 CATEGORY 6A HORIZONTAL CABLE

- A. Horizontal cabling to Wireless Access Point outlets.
- B. Performance: Transmission Characteristics: ANSI/TIA/EIA-568-B.2-10 standard for Category 6A UTP cable.
- C. Meet applicable requirements of ANSI/ICEA S-80-576.
- D. Four 22-24 AWG Twisted pairs.
- E. The overall diameter of the cable less than 0.28 inches.
- F. The ultimate breaking strength measured in accordance with ASTM D 4565 400 N minimum.
- G. Lead free cable jackets and rated for its installed environment.
- H. Withstand a bend radius of 1-inch at -20 degrees C without jacket or insulation cracking.
- I. Cable jacket color: blue

2.03 CATEGORY 6 HORIZONTAL CABLE

- A. Horizontal cabling to all other outlets.
- B. Performance: Transmission Characteristics: ANSI/TIA/EIA-568-B.2-10 standard for Category 6 UTP cable.
- C. Meet applicable requirements of ANSI/ICEA S-80-576.
- D. Four 23 AWG Twisted pairs.
- E. The overall diameter of the cable less than 0.28 inches.
- F. The ultimate breaking strength measured in accordance with ASTM D 4565 400 N minimum.
- G. Lead free cable jackets and rated for its installed environment.
- H. Withstand a bend radius of 1-inch at -20 degrees C without jacket or insulation cracking.

- I. Cable jacket color:
 - 1. Data/VoIP: Blue
 - 2. HVAC: black
 - 3. Lighting: Green
 - 4. AV Systems: Orange
 - 5. Paging: Pink
 - 6. Fire Alarm: Red
 - 7. Other Systems: Grey

2.04 CATEGORY 6A JACKS - WIRELESS ACCESS POINTS

- A. Performance:
 - 1. Physical Characteristics:
 - a. Keystone style.
 - b. Functional from -10 degrees F to 140 degrees F.
 - c. Test in accordance with ANSI/EIA/TIA-568-B.2-1 for Category 6 and 6A UTP cable.
 - d. Modular RJ45 jacks that snap into user configurable faceplates meeting durability requirements specified in IEC 603-7.
 - e. RJ45 type suitable for eight 22-26 AWG wires and be certified Category 6A compliant.
 - f. Construct jacks of high-impact plastic.
 - g. Separate and align conductors internally by separate compartments within the jack.
 - h. Wired in accordance with EIA/TIA T568B polarization sequence.
 - i. Jack color: TBD by BSD

2.05 CATEGORY 6 JACKS – ALL OTHER OUTLETS

- A. Performance:
 - 1. Physical Characteristics:
 - a. Keystone style.
 - b. Functional from -10 degrees F to 140 degrees F.
 - c. Test in accordance with ANSI/EIA/TIA-568-B.2-1 for Category 6 and 6A UTP cable.
 - d. Modular RJ45 jacks that snap into user configurable faceplates meeting durability requirements specified in IEC 603-7.
 - e. RJ45 type suitable for eight 22-26 AWG wires and be certified Category 6 compliant.
 - f. Construct jacks of high-impact plastic.
 - g. Separate and align conductors internally by separate compartments within the jack.
 - h. Wired in accordance with EIA/TIA T568B polarization sequence.
 - i. Provide jacks in the following colors:
 - 1) Standard 2-port Data Outlet: (1) white, (1) orange

2) Atypical outlets: TBD by BSD

2.06 FACEPLATES

- A. Provide stainless steel for all faceplates with labels, label faceplates according to the guidelines set forth in Section 27 08 00 – Testing, Identification, and Administration for Communication Systems.
- B. Single gang faceplates, 2-3/4-inch by 4-1/2-inch
- C. Double-gang faceplates, 4-1/2-inch by 4-1/2-inch
- D. Keystone style.
- E. 4 port standard.
- F. Provide blank inserts for unfilled outlet locations.
- G. Finish: as selected by Architect.
- H. UL Listed

2.07 WALL PHONE WALL JACK ASSEMBLY

- A. Stainless steel construction
- B. Mounting lugs designed to mate with corresponding telephone base plate or adapter.
- C. Mount to single gang outlet box.
- D. Wired to TIA-568B Standards.

2.08 PATCH CABLES – CATEGORY 6A (WIRELESS ACCESS POINTS)

- A. Patch cables are part of the horizontal channel and tested as specified in Section 27 08 00, Commissioning for Communications Systems.
- B. Provide (furnish and install) one workstation patch cable at each Wireless Access Point outlet and one equipment patch cable at the patch panel location. (This assumes 50% port activation.)
- C. Physical Characteristics:
 - 1. Verify lengths with BSD prior to procurement.
 - 2. Stranded conductors and meet Category 6A performance criteria as defined by TIA 568-B.2-1.
 - 3. Lengths required will range from 3 to 15 feet as required by Owner's authorized representative.
 - a. 15-foot workstation cords for 50 percent of the installed Category 6A cables.
 - b. 4-foot patch cords for 25 percent of the installed Category 6A cables.
 - c. 6-foot patch cords for 25 percent of the installed Category 6A cables.
 - 4. Provide the following color:
 - a. Access Points White

2.09 PATCH CABLES – CATEGORY 6

- A. Patch cables are part of the horizontal channel and tested as specified in Section 27 08 00, Commissioning for Communications Systems.

- B. Provide (furnish and install) patch cables for the following:
 - 1. HVAC and other mechanical systems
 - 2. Lighting control panels
 - 3. AV Systems
 - 4. Paging
 - 5. Electronic Security Systems (Access Control and Intrusion Detection Systems)
 - 6. Fire Alarm
- C. Patch cables for data and VoIP outlets will be furnished and installed by BSD.
- D. Physical Characteristics:
 - 1. Verify lengths with BSD prior to procurement.
 - 2. Stranded conductors and meet Category 6 performance criteria as defined by TIA 568-B.2-1.
 - 3. Lengths required will range from 3 to 15 feet as required by Owner's authorized representative.
 - a. 15-foot workstation cords for 80 percent of the installed faceplates.
 - b. 4-foot patch cords for 40 percent of the installed faceplates.
 - c. 6-foot patch cords for 40 percent of the installed faceplates.
 - d. 4-foot patch cords for 20 percent of the installed faceplates.
 - e. 6-foot patch cords for 20 percent of the installed faceplates.
 - 4. Provide the following colors:

a. HVAC	Black
b. Other mechanical systems	Purple
c. General Lighting	Blue
d. Specialty Lighting (production)	Orange
e. AV Systems	Orange
f. Paging	Pink
g. Security IP Systems	Pink
h. Fire Alarm	Red
i. Other systems	TBD by BSD

PART 3 EXECUTION

3.01 INSTALLATION

- A. Configure horizontal cabling in a star topology. The horizontal cabling includes the horizontal cables, mechanically connected jacks, outlets, and faceplates.
- B. Cables installed in under slab conduits shall be manufactured with jackets rated for damp or wet applications and employ proper moisture blocking techniques in construction.

- C. Conduits to Data Outlets shall be a minimum of 1-inch diameter. Conduit pathways and sleeves shall be EMT conduit. All conduits shall have appropriate bushings installed on the ends prior to cabling being pulled. In case EMT conduit cannot be used, 1-1/4 flexible metallic conduit may be used. Nylon pull strings shall be used in all conduit sleeves and pathways. Runs shall be less than 90 meters in length and contain no more than two 90° bends.
- D. Conduit shall be sized to accommodate initial cable requirements plus a 50 percent expansion without exceeding the current NEC fill ratio requirements.
- E. All conduits shall be supported independently of the ceiling support system.
- F. Conduit sleeves that protrude through a floor shall terminate 3-inches to 6-inches above the surface of the floor. Backbone cabling shall be routed in separate conduits from horizontal cabling.
- G. Installation of raceways/pathways for telecommunication distribution systems shall be in accordance with applicable portions of ANSI/TIA-569-B. Horizontal cabling shall be routed from each Data Outlet to a frame room using a combination of boxes, conduit, open cabling supports, and cable tray. In new construction, cabling pathways shall be concealed in walls, casework, concrete slabs, and above ceilings whenever possible. In renovations to existing spaces, the horizontal and backbone cabling may be routed in surface raceway when no other cost effective options exist.
- H. Open cabling supports shall be installed parallel, or at right angles, to the building structure and shall be permanently anchored to building structure or substrates using beam clamps, drop wire, or threaded rod hanger brackets. Open cabling supports shall be J-hook type cable supports with an open-top and wide base designed for supporting telecommunications cabling. J-hook supports should be sized in accordance with manufacturer's recommendations for quantity of cables supported. Fiber optic backbone cabling shall be installed with inner duct when routed using open cabling methods.
- I. Standard Data Outlets
 - 1. The Standard Data Outlet shall be housed in a recessed 25/8-inch deep by 4-inch square outlet box flush to the wall with single gang mud ring. A 1" conduit and pull string shall be installed from the outlet box to an accessible ceiling space. Appropriately rated bushings shall be installed on the end of the conduit stubbing into the accessible ceiling space.
 - 2. Data Outlet Labels:
 - a. Label in accordance with BSD labeling standard for data drops.
 - b. Non-removable, typed or machine-engraved.
 - c. Identify the Data Distribution Room, patch panel, and port number on the patch panel to which the horizontal cable terminates.
 - d. Install into the recess label field on the faceplate.
- J. UTP Cable:
 - 1. Conceal wiring in walls or soffits. Install in metal conduits.
 - 2. Install exposed wiring in surface raceway.
 - 3. Install wiring above ceilings in cable tray or open top cable hangers.

4. Support cable above accessible ceilings 5-foot on center (or less) from cable support attached to building structure.
 5. Do not untwist cable pairs more than 1/2-inch when terminating.
 6. Responsible for replacing cables that do not pass testing and administration requirements laid out in Section 27 08 00, Testing, Identification, and Administration of Communications Systems.
 7. Maximum length, 90 meters.
 8. No physical defects such as cuts, tears, or bulges in the outer jacket. Replace defective cables.
 9. Install cable in neat and workmanlike manner. Neatly bundle and tie cable in closets. Leave sufficient cable for 90 degree sweeps at vertical drops.
 10. Maintain the following clearances from EMI sources.
 - a. Power Cable: 6-inches
 - b. Fluorescent Lights: 12-inches
 - c. Transformers: 48-inches
 11. Do not install Category 6 or 6A UTP cable with more than 25 pounds pull force, as specified in EIA/TIA and BICSI installation practices. Utilize appropriate cable lubricant in sufficient quantity to reduce pulling friction to acceptable levels on:
 - a. Long pulls inside conduit, pulls of multiple cables into a single small bore conduit, on conduit runs greater than 100 lineal feet with bends of opposing directions, and in conduit runs that exceed 180 degrees of accumulated bends.
 - b. Use of tensile rated cords (i.e., fishing line) should be used for difficult or questionable pulls – to judge to go/no-go condition of the conduit and pulling setup. Utilize thin-coat lubricants when feasible.
 12. Replace cables jackets that are chaffed or burned exposing internal conductor insulation or have bare copper, shiners.
 13. Firestop openings where cable is installed through a fire rated wall or enclosure.
 14. Slack for Wireless Access Point outlets shall be 10'-0", coiled on a j-hook in the ceiling space above the WAP.
- K. Inserts and Faceplates:
1. Terminate cables with high density modular jacks that snap into a faceplate mounted on a wall outlet box, surface raceways, or power pole.
 2. Secure outlet boxes to building with mechanical fasteners. Adhesive fasteners are not allowed.
 3. Fill extra openings with blank inserts.
 4. Terminate cable per EIA/TIA T568B standard pin assignments.
 5. Locate so that combined length of cables and cords from panel to phone or computer does not exceed 3m.

6. Data outlet labels shall be installed into the recess label field on the faceplate.

END OF SECTION

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SECTION 27 51 16
PUBLIC ADDRESS SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

- A. Scope of work
 - 1. Expand existing system to accommodate new devices. Maintain existing zoning. Add required power supplies, amplifiers, or accessories as necessary to support new speakers in each area indicated on the drawings.
- B. System Capabilities
 - 1. System shall be able to provide the following functions:
 - 2. At least eight separate, individually programmable time schedules
 - 3. Individual events of each schedule shall be capable of sounding nine distinct user defined tones
 - 4. Allow schedules to run individually or simultaneously
 - 5. Two priority levels of all-call capability
 - 6. Provide integral internal program clock for time-tone distribution and other time related functions
 - 7. Allow for the program clock to be synchronized from the external master clock system
 - 8. utilized for the school
 - 9. Interface to the telephone system for general paging from any telephone instrument.
- C. Cabling
 - 1. Furnish and install all cable as recommended by the manufacturer. Size wiring to match line length. Route each speaker to the paging head end in Administration and terminate on a 66 split block.
- D. This Section includes:
 - 1. Ceiling and Wall Speakers
 - 2. Speaker Baffles and Enclosures
 - 3. Horns
 - 4. Cabling

1.02 RELATED SECTIONS

- A. Division 01, General Requirements
- B. Division 27, Communications
- C. Section 27 05 00, Common Work Results for Communications
- D. Section 27 05 28, Pathways for Communications Systems

1.03 REFERENCES

- A. References, Codes and Standards as required by Section 270500 – Common Work Results for Communications and Division 01, General Requirements.

1.04 QUALITY ASSURANCE

- A. Conform to the quality assurance requirements of Section 270500 – Common Work Results for Communications and Division 01, General Requirements.
- B. Qualifications
 - 1. Minimum five years documented experience in the Portland Metro area and with service facilities within 100 miles of Project. Staff includes at least one factory-trained technician certified by manufacturer of this equipment.

1.05 SUBMITTALS

- A. Including, but not limited to: Product Data Sheets, Shop Drawings, etc.
- B. General: Submit in accordance with Section 270500 – Common Work Results for Communications submittal requirements.
- C. Closeout Submittals: Submit in accordance with Section 270500 – Common Work Results for Communications submittal requirements.
- D. Provide data sheets on equipment being provided, wiring diagrams showing typical field wiring connections, and system field wiring diagrams showing proposed zoning and routing of speaker cabling. Provide paging zone maps and documentation of station addresses and punchdown block layout. Provide As-Built Drawings showing any changes to the submitted documentation during construction.

1.06 SYSTEM OPERATION

- A. Performance
 - 1. Public address system provides paging throughout areas of the building at a minimum of 6 dB above the ambient noise level.
 - 2. Make provisions for additional signal inputs into the system.
 - 3. Provide public address system input into assisted listening transmitter system.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Ceiling and Wall Speakers:
 - 1. Rauland
 - 2. Or approved equal.
- B. Speaker Baffles and Enclosures:
 - 1. Rauland
 - 2. Or approved equal.
- C. Horns:
 - 1. Rauland

- 2. Or approved equal.
- D. Cabling:
 - 1. Commscope
 - a. Uniprise
 - b. Systemax
 - 2. Or approved equal.

2.02 CEILING AND WALL SPEAKERS

- A. UL listed single voice coil, 8-inch diameter, 8 Ohm impedance, with 10 ounces ceramic magnet, and 70 volt line transformers, tapped in 5 steps from 1/4W to 5W.
- B. Frequency response, 70 to 10,000 Hz with an 8 watt RMS power rating.

2.03 SPEAKER BAFFLES AND ENCLOSURES

- A. Baffle: Flush 12-inch diameter perforated metal with white semi-gloss epoxy finish.
- B. Enclosure:
 - 1. Recessed round backbox with resonance damping material and T-bar mounting device.
 - 2. Four, 1/2-inch / 3/4-inch knockouts.
 - 3. Quam ERD8/SSB-2 or approved.

2.04 HORNS

- A. Rectangular 9-inch by 12-inch loudspeaker with integral driver and 1.5-inch diameter voice coil.
- B. Sound Pattern: 60 degrees horizontal and 40 degrees vertical beam width over a 400-6,500 Hz frequency range.
- C. Positive lock swivel bracket provides orientation adjustment in three planes.
- D. Provide built-in 70V line transformer 5 step adjustments from 1.9W to 30W. University Sound PA30T or approved.

2.05 CABLING

- A. Speaker: Two conductors stranded tinned copper, twisted pair, 16 gage, PVC jacket.
- B. Sensing Microphone: Two conductors shielded, stranded tinned copper, twisted pair, 18 gage, PVC jacket.

PART 3 EXECUTION

3.01 INSTALLATION

- A. All paging equipment shall be mounted in a manner that allows easy access for maintenance without using ladders.
- B. All speakers shall be individually connected (home run) and terminate on a 66 split block at the same location as the telephone switch.
- C. Bridging clips will be used to connect paging equipment to individual speaker lines. No other connection method will be approved.
- D. Final speaker terminations made by the equipment supplier.

- E. Install amplifiers and other equipment per manufacturer's recommendations and as detailed on the Drawings.
- F. Adjust speaker taps for uniform sound coverage.
- G. Adjust automatic level controllers for proper operation in assembly area.
- H. Install assisted listening transmitter in equipment rack. Connect audio input and antenna.

3.02 WIRING

- A. Install with conduits, outlet boxes, enclosure fittings, connectors, and accessories necessary to ensure a complete operating system in compliance with applicable codes and regulations.
- B. Conduit: Install in accordance with Section 26 05 33 – Raceways and Boxes for Electrical Systems.
- C. Wire and Cable:
 - 1. Install wiring in metal conduit or within equipment.
 - 2. Cable, lace, and tag cables within equipment with E-Z code markers indicating circuit number and type.
 - 3. Use markers on power conductors at each outlet to pull box at each equipment enclosure.
 - 4. Do not install microphone wiring in conduits carrying speaker wires.
- D. Install conduit identification labels as detailed on the Drawings.

3.03 DRAWINGS

- A. Installation and Record Drawings called for under submittals consist of reproducible drawings with outlets, devices, terminal cabinets, conduits and wiring shown. Prints of these drawings submitted to the Engineer for approval prior to starting installation.
- B. Submit drawings, when approved, then form the basis for installation.
- C. At the completion of the work, deviations from the installation drawings incorporated on the reproduces to indicate as-built conditions. Drawings will then be submitted to the Engineer as Record Drawings for the system.

3.04 TESTING

- A. Test cables and wiring for continuity, shorts, and grounds by use of an ohmmeter prior to energizing circuits.
- B. Provide instruments, equipment, and personnel necessary for testing of electrical installations and make sure such personnel are available during final testing to make immediate adjustments.
- C. Maintain written records of test results, with data carefully and accurately assigned to the cable identification as specified.
- D. Perform testing in the presence of the Owner unless specifically waived.
- E. Submit a copy of test data the Owner.
- F. Factory-trained representative of manufacturer to supervise the final testing of the system.
- G. Testing subject of approval and acceptance of the Owner.

3.05 TRAINING

- A. Conduct a minimum of two maintenance training sessions (one for each shift). Maintenance training sessions includes walk-thru of the completed facilities identifying the location, address, and means of access to every device.
- B. Training sessions with fully qualified, trained representatives of the equipment manufacturer who is thoroughly knowledgeable of the specific installation.

END OF SECTION

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SECTION 28 16 00
INTRUSION DETECTION

PART 1 GENERAL

1.01 SUMMARY

- A. Scope of Work
 - 1. Expand existing Bosch intrusion alarm panels and power supplies as required for new devices.
 - 2. Add as required to existing intrusion alarm system:
 - a. Additional panels, zone extenders and power supplies.
 - 3. Maintain existing areas or zoning.
 - 4. Maintain lighting control integration.
 - a. In the event of an alarm activation, the following lights shall be activated: egress way and all exterior spaces.
 - 5. Furnishing and installing wiring and conduit, junction boxes, pull boxes, terminal enclosures, etc., necessary for system wiring.
 - 6. Network switches will be provided by the District. All other network associated components called out in the bid documents are to be provided under contract.
- B. This Section includes:
 - 1. Alarm Management System
 - 2. End Devices
 - 3. Power Supplies

1.02 RELATED SECTIONS

- A. Division 01, General Requirements
- B. Division 28, Electronic Safety and Security
- C. Division 26, Electrical

1.03 QUALITY ASSURANCE AND SUPPLIER QUALIFICATIONS

- A. Supply and install card access control equipment by the manufacturer's authorized local distributor, who has been actively engaged in the sale, design, installation, and service of the supplied card access control system for a minimum of five years.
- B. Supplier trained in the proper installation, operation, and service of the equipment by the manufacturers whose equipment is being supplied.
- C. Provide the design team and owner with experience references, client contacts and locations of a minimum of three systems currently maintained, and a record of product sales for the provided product.
- D. Product support and maintenance staff capable of providing technical assistance and diagnostics via phone system with a 4 hour response from time of contact, and an on-site response time of 24 hours from time of contact.

- E. Provide a compliance report listing specification items that can and cannot be complied with.

PART 2 PRODUCTS

2.01 MOTION DETECTION

1. Bosch, ISC-PPR1-W16 or most current model. They shall have all functional device lighting / alert features activated. They shall be labeled with a number which can be read when standing at ground level. The number on the device shall match that on the point map and on the as-built drawings.

2.02 DOOR POSITION SENSORS

1. Bosch ISN-CTC75 or most current model. To meet both intrusion and access control operation, DPDT, Interlogix UTC 1078/1076 Series door contacts, or equal, are approved.

2.03 HARDWARE

1. Tamper-resistant fasteners: Use only stainless steel screws with approved head design for exposed fasteners on security system devices and equipment in unsecured interior areas and outdoors.
- B. Door Position Switch:
1. Hermetically sealed magnetic reed switch
 2. Single-pole, double throw momentary contact
 3. Wide-gap model
 4. Compatible with door types specified
- C. Request to Exit
1. Passive infrared sensor
 2. Minimum ± 14 degrees vertically adjustable beam pattern
 3. Form "C" contact sets
 4. 12-30 VDC power
 5. Finish: To match adjacent architectural finishes.

2.04 POWER SUPPLIES

- A. 12 VDC and 24 VDC as required to remotely power access control and intrusion detection devices.
- B. Integrated wall mount enclosures.

PART 3 EXECUTION

3.01 GENERAL

- A. Install system components and appurtenances in accordance with the manufacturers' instructions, ANSI C2.
- B. Install control signals, communications, and data transmission lines grounding as necessary to preclude ground loops, noise, and surges from affecting system operation.
- C. Equipment, materials, installation, workmanship, inspection, and testing in accordance with manufacturers' recommendations and as modified herein.

- D. Consult the manufacturers' installation manuals for wiring diagrams, schematics, physical equipment sizes, etc., before beginning system installation. Refer to the Riser/Connection diagram for schematic system installation/termination/wiring data.
- E. Attach equipment to walls and ceiling/floor assemblies and hold firmly in place. Use adequate support for fasteners and supports to support the required load.
- F. CORROSION PROTECTION
 - 1. All materials including bolts, straps, and screws shall be inherently corrosion resistant or protected against corrosion by corrosion-resistant materials approved for the purpose.

3.02 EXAMINATION

- A. Examine pathway elements intended for cables.
- B. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.
- C. Examine roughing-in for LAN and control cable conduit systems to PCs, Controllers, card readers, and other cable-connected devices to verify actual locations of conduit and back boxes before device installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.03 PREPARATION

- A. Comply with recommendations in SIA CP-01.
- B. Comply with EIA/TIA-606, Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.
- C. Obtain detailed Project planning forms from manufacturer of access-control system; develop custom forms to suit Project.

3.04 CABLING

- A. Comply with NECA 1, Good Workmanship in Electrical Contracting.
- B. Install cables and wiring according to requirements in Division 28 – Electronic Safety and Security.
- C. Wiring Method:
 - 1. Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces where unenclosed wiring method may be used.
 - 2. Use NRTL-listed plenum cable in environmental air spaces, including plenum ceilings.
 - 3. Conceal raceway and cables except in unfinished spaces.
- D. Install LAN cables using techniques, practices, and methods that are consistent with Category 6 rating of components and that ensure Category 6 performance of completed and linked signal paths, end to end.
- E. Install cables without damaging conductors, shield, or jacket.
- F. Provide a lock for boxes and enclosures containing security system components or cabling, and which are easily accessible to employees or to the public.

- G. Boxes above ceiling level in occupied areas of the building are not considered accessible.
- H. Junction boxes and small device enclosures below ceiling level and easily accessible to employees or the public, cover with a suitable cover plate and secure with tamperproof screws
- I. Install end-of-line resistors at the field device location and not at the Controller or panel location.

3.05 CABLE APPLICATION

- A. Comply with EIA/TIA-569, Commercial Building Standard for Telecommunications Pathways and Spaces.
- B. Cable application requirements are minimum requirements and exceeded if recommended or required by manufacturer of system hardware.
- C. RS-232 Cabling: Install at a maximum distance of 50-feet.
- D. RS-485 Cabling: Install at a maximum distance of 4000-feet.
- E. Intrusion alarm devices:
 - 1. Install number of conductor pairs recommended by manufacturer for the functions specified.
 - 2. Unless manufacturer recommends larger conductors, install 22 AWG wire if maximum distance from Controller to the reader is 250-feet, and install 20 AWG wire if maximum distance is 500-feet.

3.06 GROUNDING

- A. Comply with Section 260526 – Grounding and Bonding for Electrical Systems
- B. Comply with IEEE 1100, Power and Grounding Sensitive Electronic Equipment.
- C. Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
- D. Signal Ground:
 - 1. Terminal: Locate in each equipment room and wiring closet; isolate from power system and equipment grounding.
 - 2. Bus: Mount on wall of main equipment room with standoff insulators.
 - 3. Backbone Cable: Extend from signal ground bus to signal ground terminal in each equipment room and wiring closet.

3.07 INSTALLATION

- A. System installation in accordance with UL 294, manufacturer and related documents and references, for each type of security subsystem designed, engineered, and installed.
- B. Configure components with appropriate service points to pinpoint system trouble in less than 30 minutes.
- C. Design, engineer, install and test intrusion alarm system to ensure components are fully compatible as a system and can be integrated with associated security subsystems, whether the system is a standalone or a network.

- D. For programming purposes refer to the manufacturers requirements for correct system operations. Ensure computers being utilized for system integration meet or exceed the minimum system requirements outlined on the systems software packages.
- E. Visit the site and verify that site conditions are in agreement with the design package. The Report changes to the site or conditions that will affect performance of the system. Do not take corrective action without written permission from the Owner.
- F. Cold Galvanizing:
 - 1. Field welds and brazing on factory galvanized boxes, enclosures, and conduits.
 - 2. Coat with a cold galvanized paint containing at least 95 percent zinc by weight.
- G. Door Position Sensor:
 - 1. Install signal input and output cables and power cables.
 - 2. Surface mounted and angled in a manner that they cannot be compromised from the non-secure side of a windowed door, or allow for easy release of the locking device from a distance no greater than 6-feet from the base of the door.
 - 3. Surface for flush mount door position sensors and wide gap with the ability to operate at a maximum distance of up to 2-inches.
- H. Supplemental Contractor Quality Control:
 - 1. Provide the services of technical representatives who are familiar with components and installation procedures of the installed intrusion alarm system; and are approved by the Contracting Officer.
 - 2. Provide technical assistance on the job site during the preparatory and initial phases of quality control.
 - 3. Available on an as needed basis to provide assistance with follow-up phases of quality control.
 - 4. Participate in the testing and validation of the system and provide certification that the system installed is fully operational as construction document requirements have been fulfilled.

3.08 SYSTEM SOFTWARE

- A. Configure, and test software and databases for the complete and proper operation of systems involved.

3.09 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. LAN Cable Procedures:
 - a. Inspect for physical damage and test each conductor signal path for continuity and shorts. Use Class 2, bidirectional, Category 5 tester.
 - b. Test for faulty connectors, splices, and terminations. Test according to TIA/EIA-568-1, Commercial Building Telecommunications Cabling Standards - Part 1 General Requirements.
 - c. Link performance for UTP cables must comply with minimum criteria in TIA/EIA-568-B.

2. Test each circuit and component of each system. Tests include, but are not limited to:
 - a. Measurements of power supply output under maximum load.
 - b. Signal loop resistance
 - c. Leakage to ground where applicable.
3. Operate system components with battery backup battery power for a period of not less than 10 percent of the calculated battery operating time.
4. Provide special equipment and software if testing requires special or dedicated equipment.
5. Operational Test:
 - a. After installation of cables and connectors, demonstrate product capability and compliance with requirements.
 - b. Test each signal path for end-to-end performance from each end of pairs installed.
 - c. Remove temporary connections when tests have been satisfactorily completed.

END OF SECTION

SECTION 28 30 00
FIRE DETECTION AND ALARM

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. The provisions of Division 26 Section, Common Work Results for Electrical, apply to this section.

1.02 SUMMARY

- A. This Section includes:
 - 1. Replacing and expanding the existing facility fire alarm system.
 - 2. Design, furnish, install, and provide all labor, materials, and equipment required for a complete and operating system of manual and automatic initiating devices, audio/visual annunciation, voice communication with control panels, amplifier(s), speakers, auxiliary relays, power supplies, batteries and all accessories necessary to accomplish the desired sequence of events.
 - 3. The system shall be fully electronic and addressable as described below with monitoring and annunciation of all system alarms and troubles.
- B. Related Sections include:
 - 1. Section 26 05 19 Low Voltage Electrical Power Conductors and Cables
 - 2. Section 26 05 33 Raceways and Boxes for Electrical Systems
 - 3. Section 26 05 53 Identification for Electrical Systems

1.03 QUALITY ASSURANCE

- A. Equipment shall be approved and installed in accordance with NFPA, ADA and IBC requirements and shall be UL listed both in individual components and as a system. All equipment shall be ISO-9000 certified; UL & FM listed and meet NFPA 72.
- B. The system supplier shall furnish evidence that there is an experienced and efficient service organization which carries a stock of repair parts for the system to be furnished and that the organization is capable of providing repair service within 24 hours of a trouble call.
- C. The system shall be installed by an electrical contractor experienced in the installation of addressable fire alarm systems and certified by the national institute for certification in engineering technologies (NICET) for fire alarm systems. The services of the control equipment factory representative shall be obtained to provide engineered system floor plans and point-to-point drawings on AutoCAD. The representative shall supervise the installation, system start-up, programming, make final adjustments and provide testing of the completed system. The factory representative shall provide a letter of system certification to the Architect.

1.04 CONTRACTOR DESIGN

- A. The equipment shown on the contract drawings indicate the general nature of the fire alarm system, but does not necessarily show all components required. It is the responsibility of the contractor to provide a complete fire alarm and communications system as needed to meet all applicable codes and requirements under this section.
- B. It is the responsibility of the contractor to review various sets of drawings for initiating and notification devices, and add devices if needed to comply with the requirements of NFPA 72.
- C. Raceway, routing, and wiring for field devices are not shown on the drawings except for a few specific design requirements.

1.05 SUBMITTALS

- A. Shop drawings produced in AutoCAD with Fire Marshal's stamp of approval.
- B. Product data with wiring schematics.
- C. AutoCAD wiring diagrams of each type of device.
- D. AutoCAD riser diagram of the complete system(s).
- E. Battery and voltage drop calculations based on intended routing and wiring.
- F. Shop drawings of the system shall be prepared by the manufacturer in AutoCAD and submitted to the Fire Marshal for approval. The approved shop drawings will be utilized as the installation drawings. The shop drawings shall show actual conduit routing and conductors as to be installed. These drawings shall be updated by the contractor to include any revisions and changes to the system during construction and installation.

1.06 SYSTEM DESCRIPTION

- A. The automatic fire detection systems shall operate in a local, supervised non-coded fashion. The system shall be low voltage operating at 24 volts DC. The system shall be fully addressable with analog technology for all sensors. Signal circuits shall be either class "A" or "B" without changing modules. System shall be designed class "B". All circuits shall be loaded to 75 percent capacity maximum.
- B. All signal, visual and audible alarms, flow and tamper module circuits shall be supervised for all opens, shorts and grounds. Any open, short or ground shall cause a trouble on the system, sound the audible trouble sounder and annunciate at the control and remote annunciator: the device, location and nature of the trouble condition.

1.07 SYSTEM OPERATION

- A. Operation of any manual or automatic initiating device shall cause an audible and visual alarm to sound, activate the control-by-event program and perform all auxiliary functions.
- B. Any fault in the circuits shall be annunciated at the control panel and the remote annunciators.
- C. System shall utilize a single pair of wires to power, transmit and receive data from the addressable analog initiating devices and to transmit commands to the remote control points. The wire shall be sized for the length of communications loop but in no event shall it be less than number 18-2 wire size.

1.08 SEQUENCE OF OPERATION

- A. The system alarm operation subsequent to the alarm activation of any manual station, automatic initiating device, or sprinkler flow/pressure switch is to be as follows:
 - 1. All audible alarm indicating appliances shall sound a digitized tone until silenced by the alarm silence switch at the control panel.
 - 2. All visual alarm indicating appliances (xenon strobes) shall display a continuous pattern until extinguished by the alarm silence switch.
 - 3. All doors normally held open by door control devices shall release. Door lock systems shall be signaled to unlock.
 - 4. A supervised signal to notify an approved central station shall be activated.
 - 5. Combination fire/smoke dampers shall de-energize to normally closed position.
- B. The alarm activation of any elevator lobby, hoistway, or machine room smoke or heat detector shall in addition to the operations listed above, cause the elevator cab to be recalled according to the following sequence:
 - 1. If the alarmed detector is on any floor other than the preferred level of egress, the elevator cab shall be recalled to the preferred level of egress.
 - 2. If the alarmed detector is on the main egress level, the elevator cabs shall be recalled to the predetermined alternate recall level as determined by the local authority having jurisdiction.
 - 3. The activation of any heat detector in an elevator hoistway or machine room shall automatically disconnect power to the elevator motor via base-mounted contacts activating the elevator feeder shunt-trip circuit breaker. Refer to drawings.
- C. The control panel shall have a dedicated supervisory service indicator and a dedicated supervisory service acknowledge switch.
- D. The activation of any standpipe or sprinkler valve tamper switch shall activate the system supervisory service audible signal and illuminate the indicator at the control panel.
 - 1. Activating the supervisory service acknowledge switch will silence the supervisory audible signal while maintaining the supervisory serviced LED on indicating the tamper contact is still in the off-normal state.
 - 2. Restoring the valve to the normal position shall cause the supervisory service indicator to extinguish thus indicating restoration to normal position.
- E. The activation of any sprinkler pre-action system pressure or low air switch shall activate the system supervisory service audible signal and illuminate the indicator at the control panel.
 - 1. Activating the supervisory service acknowledge switch will silence the supervisory audible signal while maintaining the supervisory service indicator on indicating the pressure/air contact is still in the off-normal state.
 - 2. Restoring the air pressure to the normal shall cause the supervisory service indicator to extinguish thus indicating restoration to normal position.

- F. Alarm and trouble conditions shall be immediately displayed on the control panel front alphanumeric display and of remote annunciators. If more alarms or troubles are in the system the operator may scroll to display new alarms.
- G. The system shall have an alarm list key that will allow the operator to display all alarms, troubles, and supervisory service conditions with the time of occurrence.
- H. In normal operation, fire alarm system shall close all combination fire/smoke dampers when corresponding fan system is OFF. Fire alarm system shall open all combination fire/smoke dampers when corresponding fan system is ON.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Simplex.

2.02 CONTROL PANEL

- A. Provide processor, switches, relays, solid state indicator lamps and displays, wiring, terminals, etc., as required for operation, supervision and control of complete system.
- B. General: Microprocessor based, point identified system utilizing twisted pair 18 to 12 AWG, depending on distance, class B communication loop. Equip for a minimum of four loops.
- C. Cabinet: 16-gauge enameled steel designed for two level access. Level 1 to give access to the interface control panel. Level 2 to give access to the electronics.
- D. Outputs: Two general alarm signal circuits, programmable signal circuits, alarm contacts, trouble contacts, and RS485 annunciator line circuit.
- E. Controls and Displays: Alarm silence, trouble silence, alarm/trouble acknowledge, and reset switches, 80-character LCD display, touch keypad, and power indicator.
- F. Power Supply: Minimum 1.8 amperes of regulated, filtered power at 24 VDC plus 3.0 amperes unregulated.
- G. Failsafe Auxiliary Degrade Alarm Circuit: System will perform basic detection and alarm function and send a signal to the fire department with the CPU failed.
- H. Two-Way Loop: System capable of addressing and operating smoke detectors, manual pull stations, open contact devices and addressable auxiliary control relays on the same two-wire communication loop.
- I. Battery Back-up: Self-charging sealed lead battery backup for system auxiliary power supplies and remote annunciators in accordance with code requirements (operate 24 hours, then alarm for 5 minutes, minimum). Batteries to be monitored and initiate a trouble signal if disconnected or discharged more than 15 percent.

2.03 FIRE COMMUNICATIONS CONTROL PANEL

- A. Audio amplifiers shall be supervised, solid-state amplifiers having a frequency response of 100 to 6,000 Hz + 3dB with less than 5% distortion at rated output. The audio amplifiers shall be supervised and provide a distinct visible indication should failure occur and the system trouble signal will sound. The amplifiers shall have short-circuit protection to prevent damage due to inadvertent speaker line shorts. Upon amplifier failure, the system shall automatically switch to a backup amplifier. Capacity and number of amplifiers to be determined by total anticipated speaker load in building and provide a 5% spare capacity.
- B. Provide multiple circuits of parallel connected alarm speakers zoned as required. The speaker circuits shall be independently programmable and provide a distinct visible signal as a result of any shorts, opens or grounds in the speaker circuit wiring and the system trouble signal shall sound and the zone in trouble annunciated. Accessible controls shall be provided and identified to allow authorized personnel to transmit voice messages to individually selected signal zones. Visible indicators shall be provided to indicate that the individual signal circuit selector switch is in the voice position. Each output circuit shall have a modulation indicator for visual monitoring of circuit outputs.
- C. Provide a hand held press-to-talk microphone for transmission of messages. This module shall provide facilities to manually control the audio alarm system and transmit verbal instructions to all areas, zones, or floors, or any combination desired by the Fire Marshal.

2.04 CENTRAL STATION REPORTING

- A. Provide universal digital alarm communicator transmitter (UDACT) integral to fire alarm control panel enclosure or in stand-alone enclosure as required.

2.05 STROBE SYNCHRONIZATION

- A. Synchronize all strobes to 1Hz flash to comply with the Americans with Disabilities Act (ADA).

2.06 SOFTWARE

- A. Field Configuration Program: Provide all of the programmable operating instructions for the system resident program stored on a non-volatile EEPROM.
- B. Programming: Perform at the location of the fire alarm control using a lap-top computer system; hard copy of the system configuration is to be updated and maintained at the site.
- C. Control-By-Event: Each address shall be programmed for selective alarm output, zone verification operation, control point activation on alarm or trouble and transmit alarm to the fire department. Programmed control point activation to provide selective control.

2.07 REMOTE EQUIPMENT

- A. Annunciator Control Panels: Alphanumeric display module:
 - 1. 80 character LED/LCD display, back lighted.
 - 2. System acknowledge, signal silence, and system reset touchpad control switches.
 - 3. Time/date display.
 - 4. Integral sounder with subsequent alarm/trouble resound.
 - 5. Flush mounting.

- B. Transponders: Up to 26 field configurable circuits of any mix. Full LED/LCD display of alarm and trouble per point. Status displays and controls including power, on-line, local alarm and local trouble LED/LCD's plus reset and lamp test switches. Power supply, charger and battery as required for control panel.
- C. Lamp Driver Modules: Field selectable alarm and trouble or alarm only. Integral system trouble lamp on-line/power LED/LCD, alarm and trouble resound with flash function of new events, serial RS-485 interface to control panel, capable of being powered remotely or locally with supervision. Integral lamp test function.
- D. Power supplies, with integral chargers and batteries current limited low energy as recommended by the manufacturer but sized for 25% spare capacity.

2.08 DETECTION DEVICES

- A. Analog photoelectric smoke detectors shall provide for individual addressing of each detector. The sensor is constantly monitored to measure any change in its sensitivity due to the environment caused by dirt, aging, temperature, humidity, etc. It shall give an advanced indication to the control panel of the need for maintenance and can be specific as to where the maintenance is needed. It is to be mounted on a two wire standard device base. Photo electric detectors located within the elevator shaft shall be rated for installation within a pressurized shaft.
- B. Duct smoke detector housing assemblies shall accommodate the mounting of an analog/addressable detector along with a standard, relay or isolator detector mounting base. The housing shall also protect the measuring chamber from damage and insects. The housing shall utilize an air exhaust tube and an air sampling inlet tube that extends into the duct air stream up to twelve feet. Drilling templates and gaskets to facilitate locating and mounting the housing shall also be provided.
 - 1. Provide sampling tube length as required to accommodate air duct width.
 - 2. Provide remote status/alarm LED indicator and keyswitch test station for each duct smoke detector.
 - 3. Duct smoke detector air velocity range shall include the design air velocity of the ductwork in which the duct smoke detector is to be installed.
- C. Analog thermal detectors consist of a dual thermistor sensing circuit for fast response. The sensor is continually monitored to measure any changes in their sensitivity due to temperature. It shall give an advanced indication to the control panel of the need for maintenance and can be specific as to where the maintenance is needed. It is to be mounted on a two wire standard device base. Thermal detectors in elevator shafts and machine rooms shall be equipped with a set of auxiliary contacts for elevator equipment use. Thermal detectors located within elevator shaft shall be rated for installation within a pressurized shaft.
- D. Addressable monitor modules shall provide an address for a single, normally open initiating device such as a waterflow switch, manual station, etc. The monitor module shall be UL approved to extend the sensor loop to lengths up to 2,500'.

2.09 ANNUNCIATION DEVICES

- A. Speakers shall be mylar cone-type supplied by the panel manufacturer to ensure system compatibility and proper UL compatibility listings. Screw terminals shall be provided for wiring. Speaker housings shall be white. Speakers shall have power taps at 1/4w, 1/2w, 1w, and 2w. Speakers shall provide 90 dBA peak sound output at 2w. Speakers shall mount in 4-inch electrical boxes with extension rings using the two screws provided with each ring.
- B. Strobe lights shall be triangular with "FIRE" on white plastic lens, polarized 24 VDC, mounting single gang on four square box. Front of the unit shall allow for candela light levels as required by ADA for the spacing as installed. Strobe candela level shall be field adjustable from 15-110 CD. Mount at 80" or as shown on drawings. Finish to be white or red as selected by the Architect.
- C. Combination speaker/strobes are acceptable.
- D. The candela rating of each strobe installed shall be apparent to the Fire Marshal and to qualified service personnel either as installed or with the removal of the faceplate. If faceplates are interchangeable between strobes of different ratings the indication of candela rating shall not be on the faceplate.

2.10 ELECTROMAGNETIC DOOR HOLDERS

- A. Equipment shall consist of an armature contact plate with adjustable pivot mount, to be installed on door. A heavy-duty electromagnet, in a durable enclosure to be mounted behind the door on the wall or floor.
- B. Fail-Safe operation, loss of power shall release the door holder for the door to close.
- C. Unit shall accept 12VDC, 24VAC/VDC or 120VAC. Voltage shall be coordinated by the fire alarm system installer/supplier. Any circuitry required for the systems operation shall be provided by the system installer.
- D. All door holder equipment shall be of the same manufacturer as the fire alarm system to ensure system compatibility and proper UL compatibility listings.

2.11 ADDRESSABLE ACCESSORIES

- A. Control Modules: Connects to the same loop as the initiating devices and provides a form "C" relay contact. The module may be programmed to transfer from either a trouble or alarm input from any or combination of any addressable device.

2.12 CONTROLLED DEVICES

- A. Mechanical control system for control of air handlers and smoke/fire rated dampers.
- B. Fire protection tamper, flow, dry system and preaction system.

2.13 CABLE

- A. Plenum rated as recommended by System Manufacturer and the building construction methods.

PART 3 EXECUTION

3.01 INSTALLATION

- A. General: Install in accordance with code, UFC, UBC, NFPA 72, 101 and the manufacturer's instructions. Review proper installation of each type of device with manufacturer's agent. Install all wiring, raceway and outlet boxes required for a complete system as indicated in the Contract Documents. Comply with applicable requirements of Section 26 05 33 for boxes and surface mounted raceways.
- B. Typical Wiring: Install manufacturer's recommended listed cable to connect all devices as recommended by the manufacturer. The cable shall be run in conduit where exposed to physical damage.
- C. Detectors: Locate 48" clear of supply air vents and 12" clear of lights and sprinkler heads. Install detector heads not more than two weeks prior to substantial completion. Verify the design locations shown conform to the actual construction. Do not locate detectors in close proximity to air supply vents. Bring cases of uncertain applicability to the attention of the Architect for resolution prior to roughing in.
- D. Duct Smoke Detectors
 - 1. Provide/maintain working access to all duct smoke detectors.
 - 2. Locate duct smoke detectors in accordance with all code requirements. Locations must ensure adequate airflow within the duct housing.
 - 3. Locate remote status/alarm LED indicator and keyswitch test station at readily accessible location out of general view (e.g. above accessible ceiling) directly below duct smoke detector location. Identify locations on fire alarm shop drawings prior to installation.
- E. Install remote annunciator as indicated on plans and where required by Fire Marshall. Coordinate prior to rough-in.
- F. Provide auxiliary power supplies as required and extend the 120V power to the power supply as required and per NEC.
- G. Provide visual devices and alarm devices as required. Device locations are diagrammatic showing intent of area coverage. The exact placement, sound or light level is to be per the requirements and the listing of the manufacturer's equipment.
- H. Refer to District standards for site specific code references.

3.02 LABELING

- A. Label all alarm initiating devices with 1/2-inchx1-inch lamicoid nameplates, indicating control panel point designation. Locate nameplates in the vicinity of the device as approved by the Owner.
- B. Provide Brady type wire markers to identify all conductors at each junction or terminal. Use numbers indicated on the wiring diagrams.
- C. Refer to District standards for labeling requirements.

3.03 TESTS

- A. Provide the service of a competent, factory-trained technician authorized by the manufacturer of the fire alarm equipment to technically supervise and participate during the programming, final connections, adjustments and tests for the system.
- B. When the system is complete and prior to the substantial completion, furnish testing equipment and perform the following tests:
- C. Before energizing system, check for correct wiring connections and test for short circuits, ground faults, continuity, and insulation.
- D. Test the insulation on all installed wiring by standard methods as recommended by the equipment manufacturer.
- E. Open all supervised circuits to see if the trouble signal activates.
- F. Ground all supervised circuits and verify response of trouble signals.
- G. Check installation, supervision, operation and sensitivity of smoke detectors as recommended by the manufacturer to ascertain that they will avoid false alarm signals yet provide the required automatic detection.
- H. Test each device for proper operation and auxiliary function.
- I. Submit a print out of the entire test procedure to the engineer with the letter of certification for the completed fire alarm system.
- J. When any defects in the work are detected, make repairs and repeat the tests as required.
- K. Test system for NFPA standby and alarm runtime for the actual load on the system batteries and recharge time of system batteries.
- L. Perform all required and necessary verification of the system operating functions with the Architect and Owner's facility staff prior to turnover of the complete system for final test observed by the Fire Department. These tests shall be performed in the presence of the Owner or the Owner's Representative. A System Certification verifying the proper system operation is required prior to acceptance. Instruct Owner's personnel in system operation, maintenance and programming for a minimum of twenty (20) hours. The cost of any retesting as a result of the failure of the system to operate in accordance with these specifications, drawings, or applicable codes shall be paid for by the contractor to the Owner.

3.04 WARRANTY SERVICE AND INSTRUCTION

- A. The fire alarm system will be checked on a monthly basis by the fire alarm system service organization for a period of one year after beneficial occupancy. The monthly checks will consist of reviewing the operation of the system with the Owner's operating and maintenance personnel, providing additional hands on instruction, and assisting in execution of programming revisions. Each monthly visit will consist of not less than two hours of on-site time and no more than four hours. The monthly visits will be scheduled with the Owner not less than one week in advance.

3.05 EXTRA STOCK/SPARE PARTS

- A. Provide the following equipment to be turned over to the owner with the operation and maintenance manuals.
 - 1. 2 photoelectric smoke detector heads
 - 2. 2 thermal heat detector heads
 - 3. 1 addressable dry contact modules
 - 4. 2 speaker/strobe
 - 5. 1 complete set of fuses to match panel counts

3.06 TRAINING

- A. Provide operation and maintenance training for Owner's personnel.
- B. Conduct a minimum of two maintenance training sessions upon completion of the work. Maintenance training sessions shall include a walk-thru of the completed facilities identifying the location, address, and means of access to every device monitored by the fire alarm system.
- C. Conduct training sessions for two operator levels.
- D. Operator training. Provide a minimum of three refresher and system update training sessions of on-the-job training.
- E. Supervisor training. Provide a system update training session for supervisory functions.
- F. Training sessions with fully qualified, trained representative, of the equipment manufacturer who is thoroughly knowledgeable of the specific installation.

END OF SECTION

SECTION 32 1123
AGGREGATE BASE COURSES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Aggregate base course.
- B. Paving aggregates.

1.02 RELATED REQUIREMENTS

- A. Section 32 1216 - ASPHALT PAVING: Binder and finish asphalt courses.
- B. Section 32 1313 - CONCRETE PAVING: Finish concrete surface course.

1.03 REFERENCE STANDARDS

- A. ASTM C136/C136M - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates; 2014.
- B. ASTM D1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method; 2007.
- C. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System); 2011.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Materials Sources: Submit name of imported materials source.
- C. Aggregate Composition Test Reports: Results of laboratory tests on proposed and actual materials used.
- D. Compaction Density Test Reports.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. When necessary, store materials on site in advance of need.
- B. Verify that survey bench marks and intended elevations for the Work are as indicated.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Aggregate for base course material shall consist of granular material, either naturally occurring or processed, and shall meet the following requirements for grading and quality:
 - 1. 3/4 inch sieve: 95 to 100 percent passing.
 - 2. 1/4 inch sieve: 25% passing
 - 3. U.S. No. 40: 40% passing
 - 4. U.S. No. 200: 5% passing
 - 5. Sand equivalent: 50% max.
 - 6. All percentages by weight.
- B. Fine Aggregate : Natural river or bank sand; washed; free of silt, clay, loam, friable or soluble materials, and organic matter.
 - 1. Graded in accordance with ASTM C136/C136M; within the following limits:
 - a. No. 4 sieve: 100 percent passing.
 - b. No. 14 sieve: 10 to 100 percent passing.
 - c. No. 50 sieve: 5 to 90 percent passing.
 - d. No. 100 sieve: 4 to 30 percent passing.
 - e. No. 200 sieve: 0 percent passing.

2.02 SOURCE QUALITY CONTROL

- A. See Section 01 4000 - QUALITY REQUIREMENTS, for general requirements for testing and analysis of aggregate materials.

- B. Where aggregate materials are specified using ASTM D2487 classification, testing of samples for compliance will be provided before delivery to site.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify substrate has been inspected, gradients and elevations are correct, and is dry.

3.02 PREPARATION

- A. Correct irregularities in substrate gradient and elevation by scarifying, reshaping, and re-compacting.
- B. Do not place aggregate on soft, muddy, or frozen surfaces.

3.03 INSTALLATION

- A. Under Portland Cement Concrete Paving:
 - 1. Place base course material to a total compacted thickness of 6 inches at pedestrian areas and 6 inches at vehicular traffic areas.
 - 2. Compact to 95 percent of maximum dry density.
- B. Place aggregate in maximum 4 inch layers and roller compact to specified density.
- C. Level and contour surfaces to elevations and gradients indicated.
- D. Add small quantities of fine aggregate to coarse aggregate as appropriate to assist compaction.
- E. Add water to assist compaction. If excess water is apparent, remove aggregate and aerate to reduce moisture content.
- F. Use mechanical tamping equipment in areas inaccessible to compaction equipment.

3.04 TOLERANCES

- A. Variation From Design Elevation: Within 1/4 inch.

3.05 FIELD QUALITY CONTROL

- A. See Section 01 4000 - QUALITY REQUIREMENTS, for general requirements for field inspection and testing.
- B. Compaction density testing will be performed on compacted aggregate base course in accordance with ASTM D1556.
- C. If tests indicate work does not meet specified requirements, remove work, replace and retest.

3.06 CLEANING

- A. Remove unused stockpiled materials, leave area in a clean and neat condition. Grade stockpile area to prevent standing surface water.

END OF SECTION

SECTION 32 1216
ASPHALT PAVING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Single course bituminous concrete paving.
- B. Double course bituminous concrete paving.

1.02 RELATED REQUIREMENTS

- A. Section 09 9000 - Paints and Coatings: striping and markings
- B. Section 31 1123 - Aggregate Bases
- C. Section 32 1313 - CONCRETE PAVING: Concrete curbs.

1.03 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Materials Sources: Submit name of imported materials source.
- C. Aggregate Composition Test Reports: Results of laboratory tests on proposed and actual materials used.
- D. Compaction Density Test Reports.

1.04 REFERENCE STANDARDS

- A. AI MS-2 - Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types; 1997.
- B. ASTM D946 - Standard Specification for Penetration-Graded Asphalt Cement for Use in Pavement Construction; 2009a.
- C. ODOT: Oregon Department of Transportation

1.05 QUALITY ASSURANCE

- A. Perform Work in accordance with Washington County's Public Work's standard.
- B. Mixing Plant: Conform to Washington County's Public Work's standard.
- C. Obtain materials from same source throughout.

1.06 REGULATORY REQUIREMENTS

- A. Conform to applicable code for paving work on public property.

1.07 FIELD CONDITIONS

- A. Do not place asphalt when ambient air or base surface temperature is less than 40 degrees F, or surface is wet or frozen.
- B. Place bitumen mixture when temperature is not more than 15 degrees F below bitumen supplier's bill of lading and not more than maximum specified temperature.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Asphalt Cement: ASTM D946.
- B. Aggregate for Binder Course: In accordance with Municipality of Portland Public Work's standards.
- C. Aggregate for Wearing Course: In accordance with Municipality of Portland Public Work's standards.
- D. Fine Aggregate: In accordance with Municipality of Portland Public Work's standards.
- E. Primer: In accordance with Municipality of Portland Public Work's standards.
- F. Tack Coat: Homogeneous, medium curing, liquid asphalt.

2.02 ASPHALT PAVING MIXES AND MIX DESIGN

- A. Binder Course: 4.5 to 6 percent of asphalt cement by weight in mixture in accordance with AI MS-2.
- B. Wearing Course: 5 to 7 percent of asphalt cement by weight in mixture in accordance with AI MS-2.
- C. Submit proposed mix design of each class of mix for review prior to beginning of work.

2.03 SOURCE QUALITY CONTROL

- A. Test mix design and samples in accordance with AI MS-2.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that compacted subgrade is dry and ready to support paving and imposed loads.
- B. Verify gradients and elevations of base are correct.

3.02 PREPARATION - PRIMER

- A. Apply primer in accordance with manufacturer's instructions.
- B. Apply primer on aggregate base or subbase at uniform rate of 1/3 gal/sq yd.
- C. Use clean sand to blot excess primer.

3.03 PREPARATION - TACK COAT

- A. Apply tack coat in accordance with manufacturer's instructions.
- B. Apply tack coat on asphalt or concrete surfaces over subgrade surface at uniform rate of 1/3 gal/sq yd.

3.04 PLACING ASPHALT PAVEMENT - DOUBLE COURSE

- A. Place asphalt binder course within 24 hours of applying primer or tack coat.
- B. Place wearing course within two hours of placing and compacting binder course.
- C. Compact pavement by rolling to specified density. Do not displace or extrude pavement from position. Hand compact in areas inaccessible to rolling equipment.
- D. Perform rolling with consecutive passes to achieve even and smooth finish, without roller marks.

3.05 TOLERANCES

- A. Flatness: Maximum variation of 1/4 inch measured with 10 foot straight edge.
- B. Compacted Thickness: Within 1/4 inch of specified or indicated thickness.
- C. Variation from True Elevation: Within 1/2 inch.

3.06 FIELD QUALITY CONTROL

- A. See Section 01 4000 - QUALITY REQUIREMENTS, for general requirements for quality control.
- B. Provide field inspection and testing. Take samples and perform tests in accordance with AI MS-2.

3.07 PROTECTION

- A. Immediately after placement, protect pavement from mechanical injury for 2 days or until surface temperature is less than 140 degrees F.

END OF SECTION

**SECTION 32 1313
CONCRETE PAVING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Concrete sidewalks, stair steps, integral curbs, and gutters.

1.02 RELATED REQUIREMENTS

- A. Section 03 1000 - Concrete Forming and Accessories.
- B. Section 03 2000 - Concrete Reinforcing.
- C. Section 03 3000 - Cast-in-Place Concrete.
- D. Section 07 9200 - Joint Sealants: Sealant for joints.
- E. Section 09 9000 - Paints and Coatings: striping and markings
- F. Section 32 1123 - Aggregate Bases.
- G. Section 32 1216 - Asphalt Paving.

1.03 REFERENCE STANDARDS

- A. ACI 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete; 1991 (Reapproved 2009).
- B. ACI 301 - Specifications for Structural Concrete; 2010 (Errata 2012).
- C. ACI 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete; 2000.
- D. ACI 305R - Hot Weather Concreting; 2010.
- E. ACI 306R - Cold Weather Concreting; 2010.
- F. ASTM C39/C39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens; 2015a.
- G. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete; 2015.
- H. ASTM C173/C173M - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method; 2014.
- I. ASTM C260/C260M - Standard Specification for Air-Entraining Admixtures for Concrete; 2010a.
- J. ASTM D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types); 2004 (Reapproved 2013).
- K. ASTM D1752 - Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction; 2004a (Reapproved 2013).

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on joint filler, admixtures, and curing compound.
- C. Design Data: Indicate pavement thickness, designed concrete strength, reinforcement, and typical details.

1.05 QUALITY ASSURANCE

- A. Mock-up:
 - 1. Prepare minimum 4 x 4 feet mock-up of each specified concrete paving finish.
 - 2. Mock-ups shall include field surface and edge troweling finishes.
 - 3. Mock-ups may remain as part of the Work.

PART 2 PRODUCTS

2.01 FORM MATERIALS

- A. Form Materials: Conform to ACI 301.
- B. Joint Filler: Preformed; non-extruding bituminous type (ASTM D1751) or sponge rubber or cork (ASTM D1752).
 - 1. Thickness: 1/2 inch.

2.02 REINFORCEMENT

- A. Reinforcing Steel and Welded Wire Reinforcement: Types specified in Section 03 2000.

2.03 CONCRETE MATERIALS

- A. Obtain cementitious materials from same source throughout.
- B. Concrete Materials: As specified in Section 03 3000.
- C. Air-Entraining Admixtures: ASTM C260/C260M.

2.04 ACCESSORIES

2.05 CONCRETE MIX DESIGN

- A. Proportioning Normal Weight Concrete: Comply with ACI 211.1 recommendations.
- B. Admixtures: Add acceptable admixtures as recommended in ACI 211.1 and at rates recommended by manufacturer.
- C. Concrete Properties:
 - 1. Compressive strength, when tested in accordance with ASTM C39/C39M at 28 days; 3,000 psi. minimum.
 - 2. Total Air Content: 5 percent, determined in accordance with ASTM C173/C173M.

2.06 MIXING

- A. Transit Mixers: Comply with ASTM C94/C94M.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify compacted subgrade is acceptable and ready to support paving and imposed loads.
- B. Verify gradients and elevations of base are correct.

3.02 SUBBASE

- A. See Section 32 1123 for construction of base course for work of this Section.

3.03 PREPARATION

- A. Moisten base to minimize absorption of water from fresh concrete.
- B. Coat surfaces of manhole frames with oil to prevent bond with concrete pavement.

3.04 FORMING

- A. Place and secure forms to correct location, dimension, profile, and gradient.
- B. Assemble formwork to permit easy stripping and dismantling without damaging concrete.
- C. Place joint filler vertical in position, in straight lines. Secure to formwork during concrete placement.

3.05 REINFORCEMENT

- A. Place reinforcement at top of slabs-on-grade.
- B. Interrupt reinforcement at expansion joints.
- C. Place dowels to achieve pavement and curb alignment as detailed.

3.06 COLD AND HOT WEATHER CONCRETING

- A. Follow recommendations of ACI 305R when concreting during hot weather.

- B. Follow recommendations of ACI 306R when concreting during cold weather.
- C. Do not place concrete when base surface temperature is less than 40 degrees F, or surface is wet or frozen.

3.07 PLACING CONCRETE

- A. Place concrete in accordance with ACI 304R.
- B. Ensure reinforcement, inserts, embedded parts, and formed joints are not disturbed during concrete placement.
- C. Place concrete continuously over the full width of the panel and between predetermined construction joints. Do not break or interrupt successive pours such that cold joints occur.

3.08 JOINTS

- A. Align curb, gutter, and sidewalk joints.
- B. Place 3/8 inch wide expansion joints at 20 foot intervals and to separate paving from vertical surfaces and other components and in pattern indicated.
 - 1. Form joints with joint filler extending from bottom of pavement to within 1/2 inch of finished surface.
 - 2. Secure to resist movement by wet concrete.
- C. Provide scored joints.
 - 1. At 5 feet intervals max.
 - 2. Between sidewalks and curbs.
 - 3. Between curbs and pavement.

3.09 FINISHING

- A. Area Paving: Light broom, texture perpendicular to pavement direction.
- B. Sidewalk Paving: Light broom, texture perpendicular to direction of travel with troweled and radiused edge of 1/4 inch radius or as specified by local municipality in public ROW.
- C. Curbs and Gutters: Light broom, texture parallel to pavement direction or as specified by school district
- D. Inclined Vehicular Ramps: Medium combed textured.
- E. Place curing compound on exposed concrete surfaces immediately after finishing. Apply in accordance with manufacturer's instructions.

3.10 JOINT SEALING

- A. See Section 07 9200 for joint sealant requirements.

3.11 TOLERANCES

- A. Maximum Variation of Surface Flatness: 1/4 inch in 10 ft.
- B. Maximum Variation From True Position: 1/4 inch.

3.12 FIELD QUALITY CONTROL

- A. An independent testing agency will perform field quality control tests, as specified in Section 01 4000 - QUALITY REQUIREMENTS.
 - 1. Provide free access to concrete operations at project site and cooperate with appointed firm.
 - 2. Submit proposed mix design of each class of concrete to inspection and testing firm for review prior to commencement of concrete operations.
- B. Compressive Strength Tests: ASTM C39/C39M; for each test, mold and cure three concrete test cylinders. Obtain test samples for every 100 cu yd or less of each class of concrete placed.
 - 1. Take one additional test cylinder during cold weather concreting, cured on job site under same conditions as concrete it represents.
 - 2. Perform one slump test for each set of test cylinders taken.

- C. Maintain records of placed concrete items. Record date, location of pour, quantity, air temperature, and test samples taken.

3.13 PROTECTION

- A. Immediately after placement, protect pavement from premature drying, excessive hot or cold temperatures, and mechanical injury.
- B. Do not permit pedestrian traffic over pavement for 7 days minimum after finishing.

END OF SECTION

SECTION 32 8400

IRRIGATION

PART 1 – GENERAL

1.1 SUMMARY

- A. Irrigation system required for this work includes but is not limited to the furnishing of all labor, tools, materials, appliances, tests, permits, taxes, etc., necessary for the installation of a landscape irrigation system as herein specified and shown on the drawings, and the removal of all debris from the site.
 - 1. Locate, purchase, deliver and install piping, conduit, sleeves, 120 volt and low voltage electrical and water connections, valves, backflow preventer devices, controllers, spray and bubbler heads, and associated accessories for a fully operational automatic irrigation system.
 - 2. Trenching and water settling of backfill material.
 - 3. Testing and startup of the irrigation system.
 - 4. Prepare an as built record set of drawings.
 - 5. Training of the Owner's maintenance personnel in the operational requirements of the Irrigation system.
 - 6. Clean up and disposal of all excess and surplus material.
 - 7. Maintenance of the irrigation system during the proscribed maintenance period.
- B. The system shall efficiently and evenly irrigate all areas and be complete in every respect and shall be left ready for operation to the satisfaction of the Owner's Representative.
- C. Coordinate with other trades, as needed to complete work, including but not limited to Water Meter, Point of Connection (POC) and Backflow Preventer Device (BFPD) location and electrical hookups.

1.2 CONTRACT DOCUMENTS

- A. Shall consist of specifications and its general conditions and the drawings. The intent of these documents is to include all labor, materials, and services necessary for the proper execution of the work. The documents are to be considered as one. Whatever is called for by any part shall be as binding as if called for in all parts.

1.3 RELATED DOCUMENTS AND REFERENCES

- A. Related Documents:
 - 1. Drawings and general provisions of contract, including general and supplementary conditions and Division I specifications, apply to work of this section.
 - 2. Related Specification Sections
 - a. Section - Planting
 - b. Section – Tree and Plant Protection
- B. References:
 - 1. American Society of Testing Materials (ASTM): cited section numbers.
 - 2. National Sanitation Foundation (NSF): rating system.
 - 3. Irrigation Association: Turf & Landscape Irrigation Best Management Practices

1.4 VERIFICATION

- A. Irrigation piping and related equipment are drawn diagrammatically. Scaled dimensions are approximate only. Before proceeding with work, carefully check and verify dimensions and immediately notify the Owner's Representative of discrepancies between the drawings or specifications and the actual conditions. Although sizes and locations of plants and or irrigation equipment are drawn to scale wherever possible, it is not within the scope of the drawings to show all necessary offsets, obstructions, or site conditions. The Contractor shall be responsible to install the work in such a manner that it will be in conformance to site conditions, complete, and in good working order.
- B. Piping and equipment is to be located within the designated planting areas wherever possible unless specifically defined or dimensioned otherwise.

1.5 PERMITS AND REGULATIONS

- A. The Contractor shall obtain and pay for all permits related to this section of the work unless previously excluded under provision of the contract or general conditions. The Contractor shall comply with all laws and ordinances bearing on the operation or conduct of the work as drawn and specified. If the Contractor observes that a conflict exists between permit requirements and the work outlined in the contract documents, the Contractor shall promptly notify the Owner's Representative in writing including a description of any necessary changes and changes to the contract price resulting from changes in the work.
- B. Wherever references are made to standards or codes in accordance with which work is to be performed or tested, the edition or revision of the standards and codes current on the effective date of this contract shall apply, unless otherwise expressly set forth.
- C. In case of conflict among any referenced standards or codes or between any referenced standards and codes and the specifications, the more restrictive standard shall apply or Owner's Representative shall determine which shall govern.

1.6 PROTECTION OF WORK, PROPERTY AND PERSON

- A. The Contractor shall adequately protect the work, adjacent property, and the public, and shall be responsible for any damages or injury due to the Contractor's actions.

1.7 CHANGES IN THE WORK

- A. The Owner's Representative may order changes in the work, and the contract sum being adjusted accordingly. All such orders and adjustments plus claims by the Contractor for extra compensation must be made and approved in writing before executing the work involved.
- B. All changes in the work, notifications and Contractor's request for information (RFI) shall conform to the contract general condition requirements.

1.8 CORRECTION OF WORK

- A. The Contractor shall re-execute any work that fails to conform to the requirements of the contract and shall remedy defects due to faulty materials or workmanship upon written notice from the Owner's Representative, at the soonest as possible time that can be coordinated with other work, and seasonal weather demands, but not more than 90 (ninety) days after notification.

1.9 DEFINITIONS

- A. Owner's Representative: The person appointed by the Owner to represent their interest in the review and approval of the work and to serve as the contracting authority with the Contractor. The Owner's Representative may appoint other persons to review and approve any aspects of the work.
- B. Substantial Completion Acceptance: The date at the end of the Planting, Planting Soil, and Irrigation installation where the Owner's Representative accepts that all work in these sections is complete and the Warranty period has begun. This date may be different that the date of substantial

completion for the other sections of the project.

- C. Final Acceptance: The date when the Owner's Representative accepts that the plants and work in this section meet all the requirements of specification. It is intended that the materials and workmanship warranty for Planting, Planting Soil, and Irrigation work run concurrently.

1.10 SUBMITTALS

- A. See the contract General Conditions for policy and procedures related to submittals.
- B. Product data
1. Submit a minimum of (3) complete lists of all irrigation equipment to be used, manufacturer's brochures, maintenance manuals, warranties and operating instructions, within 15 days after the notice to proceed.
 - a. This submission may be done digitally and all documents shall be submitted in one PDF document.
 2. The submittals shall be packaged and presented in an organized manner, in the quantity described in Division 1 of the specifications. Provide a table of contents of all submitted items.
 3. Clearly identify on each submitted sheet by underlining or highlighting (on each copy) the specific product being submitted for approval. Failure to clearly identify the specific product being submitted will result in a rejection for the entire submittal. No substitutions of material or procedures shall be made concerning these documents without the written consent of an accepted equivalent by the Owner's Representative.
 4. Equipment or materials installed or furnished without prior approval of the Owner's Representative, may be rejected by the Owner's Representative and the Contractor shall be required to remove such materials from the site at their own expense.
 5. Approval of substitution of material and/or products, other than those specified shall not relieve the Contractor from complying with the requirements of the contract documents and specifications. The Contractor shall be responsible, at their own expense, for all changes that may result from the approved substitutions, which affect the installation or operations other items of their own work and/or the work of other Contractors.
- C. Samples: Samples of the equipment may be required at the request of the Owner's Representative if the equipment is other than that specified.
- D. Other Submittals: Submit for approval:
1. Documentation of the installer's qualifications.
 2. As built record set of drawings.
 3. Testing data from all required pressure testing.
 4. Backflow prevention device certification: Certification from the manufacturer or their representative that the backflow prevention device has been installed correctly according to the manufactures requirements.
 5. Irrigation controller certification: Certification from the manufacturer or an authorized distributor that the Controller has been installed correctly according to the manufactures requirements.

1.11 OBSERVATION OF THE WORK

- A. The Owner's Representative may inspect the work at any time. They may remove samples of materials for conformity to specifications. Rejected materials shall be immediately removed from the site and replaced at the Contractor's expense. The cost of testing materials not meeting

specifications shall be paid by the Contractor.

- B. The Owner's Representative shall be informed of the progress of the work so the work may be observed at the following key times in the construction process. The Owner's Representative shall be afforded sufficient time to schedule visit to the site. Failure of the Owner's Representative to make field observations shall not relieve the Contractor from meeting all the requirements of this specification.
 - 1. Trenching, directional boring, and sleeving review.
 - 2. Hydrostatic pressure testing.
 - 3. Adjustment and coverage test.
 - 4. Pre-maintenance observation.
 - 5. Final acceptance / system malfunction corrections.

1.12 PRE-CONSTRUCTION CONFERENCE

- A. Schedule a pre-construction meeting with the Owner's Representative at least seven (7) days before beginning work to review any questions the Contractor may have regarding the work, administrative procedures during construction and project work schedule.

1.13 QUALITY ASSURANCE

- A. It is the intention of this specification to accomplish the work of installing an automatic irrigation system, which will operate in an efficient and satisfactory manner. The irrigation system shall be installed and made operational according to the workmanlike standards established for landscape installation and sprinkler irrigation operation as set forth by the most recent Best Management Practices (BMP) of the Irrigation Association.
- B. The specification can only indicate the intent of the work to be performed rather than a detailed description of the performance of the work. It shall be the responsibility of the Contractor to install said materials and equipment in such a manner that they shall operate efficiently and evenly and support optimum plant growth and health.
- C. The Owner's Representative shall be the sole judge of the true intent of the drawings and specifications and of the quality of all materials furnished in performance of the contract.
- D. The Contractor shall keep one copy of all drawings and specifications on the work site, in good order. The Contractor shall make these documents available to the Owner's Representative when requested.
- E. In the event of any discrepancies between the drawings and the specification, the final decision as to which shall be followed, shall be made by the Owner's Representative.
- F. In the event the installation is contradictory to the direction of the Owner's Representative, the installation shall be rectified by the Contractor at no additional cost to the Owner. The Contractor shall immediately bring any such discrepancies to the attention of the Owner's Representative.
- G. It shall be distinctly understood that no oral statement of any person shall be allowed in any manner to modify any of the contract provisions. Changes shall be made only on written authorization of the Owner's Representative.
- H. Installer Qualifications: The installer shall be a firm having at least 5 years of successful experience of a scope similar to that required for the work.
 - a. Installer Field Supervision: The installer shall maintain on site an experienced full-time supervisor who can communicate in English with the Owner's Representative.
 - b. Submit the installer's qualifications for approval.

1.14 IRRIGATION SYSTEM WARRANTY:

- A. The Contractor shall Warrantee all workmanship and materials for a period of one (1) year following the acceptance of the work.
 - 1. Any parts of the irrigation work that fails or is defective shall be replaced or reconstructed at no expense to the Owner including but not limited to: restoring grades that have settled in trenches and excavations related to the work. Reconstruction shall include any plantings, soil, mulch or other parts of the constructed landscape that may be damaged during the repair or that results from soil settlement.
- B. The date of acceptance of the work and start of the Guarantee period shall be determined by the Owner's Representative, upon the finding that the entire irrigation system is installed as designed and specified, and found to be operating correctly, supplying water evenly to all planting and/or lawn areas.
- C. The system controller shall be warranted by the equipment manufacturer against equipment malfunction and defects for a period of one (1) year, following the acceptance of the work.
- D. Neither the final acceptance nor any provision in the contract documents shall relieve the Contractor of responsibility for faulty materials or workmanship. The Contractor shall remedy any defects within a period of 7 days from the date of notification of a defect.

1.15 SITE CONDITIONS

- A. It is the responsibility of the Contractor to be aware of all surface and sub-surface conditions, and to notify the Owner's Representative, in writing, of any circumstances that would negatively impact the installation of the work. Do not proceed with work until unsatisfactory conditions have been corrected.

1.16 DELIVERY, STORAGE, AND HANDLING

- A. All materials and equipment shall be stored properly and protected as required by the Contractor. The Contractor shall be entirely responsible for damages or loss by weather or other cause to work under the contract. Materials shall be furnished in ample quantities and at such times as to ensure uninterrupted progress of the work.
- B. Deliver the products to the job site in their original unopened container with labels intact and legible at time of use.
- C. Store in accordance with the manufacturers' recommendations.

1.17 PROTECTION

- A. The Contractor shall continuously maintain adequate protection of all their work from damage, destruction, or loss, and shall protect the owner's property from damage arising in connection with this contract. Contractor shall make good any such damage, destruction, loss or injury. Contractor shall adequately protect adjacent property as provided by law and the contract documents.
- B. The Contractor shall maintain sufficient safeguards, such as railings, temporary walks, lights, etc., against the occurrence of accidents, injuries or damage to any person or property resulting from their work and shall alone be responsible for the same if such occurs.
- C. All existing paving, structures, equipment or plant material shall be protected at all times, including the irrigation system related to plants, from damage by workers and equipment. The Contractor shall follow all protection requirements including plant protection provision of the general contract documents. All damages shall be repaired or replaced at the Contractor's expense. Repairs and or replacement shall be to the satisfaction of the Owner's Representative, including the selection of a Contractor to undertake the repair or maintenance. Repairs shall be at no cost to the owner.

- 1. For trees damaged to the point where they will not be expected to survive, or which are severely

disfigured and that are too large to replace, the cost of damages shall be as determined by the Owner's arborist using accepted tree value evaluation methods.

- D. The Contractor shall refrain from trenching within the drip line of any existing tree to remain. The Owner's Representative may require the Contractor to relocate proposed irrigation work, bore lines beneath roots or use air spade technology to dig trenches through and under the root system to avoid damage to existing tree root areas.

1.18 EXCAVATING AROUND UTILITIES

- A. Contractor shall carefully examine the civil, record, and survey drawings to become familiar with the existing underground conditions before digging.

- 1. Do not begin any excavation until all underground utilities have been located and marked.

Determine location of underground utilities and perform work in a manner that will avoid possible damage. Hand excavate, as required. Maintain stakes and or markings set by others until parties concerned mutually agree to their removal.

- B. Notification of Oregon Utility Notification Center 1-800-332-2344, is required for all excavation around utilities. The Contractor is responsible for knowing the location and avoiding utilities that are not covered by the Oregon Utility Notification Center.

1.19 POINT OF CONNECTION

- A. The point of connection of the irrigation system to its electrical power sources shall be provided by the General Contractor's licensed electrical Contractor per governing codes at the location shown on the drawings. The irrigation Contractor will connect the power to provided junction box or grounded plug receptacle.
- B. The point of connection of the irrigation system to its potable and or non-potable water sources, including the main shutoff valve and backflow preventer shall be provided by the General Contractor's licensed plumbing Contractor per governing codes at the location shown on the drawings. The minimum size and water pressure of the pressurized line will be as noted on the irrigation drawing.

1.20 TEMPORARY UTILITIES

- A. All temporary piping, wiring, meters, panels and other related appurtenances required between source of supply and point of use shall be provided by the Contractor and coordinated with the Owner's Representative. Existing utilities may be used with the written permission of the owner.

1.21 CUTTING, PATCHING, TRENCHING AND DIGGING

- A. The Contractor shall do all cutting, fitting, trenching or patching of their work that may be required to make its several parts come together as shown upon, or implied by, the drawings and specifications for the completed project.
- B. Digging and trenching operations shall be suspended when the soil moisture is above field capacity.

1.22 USE OF PREMISES

- A. The Contractor shall confine their apparatus; the storage of materials, and the operations of their workers to limits indicated by the law, ordinances, or permits and shall not unreasonably encumber the premises with their materials.
- B. Contractor parking, and material and equipment storage shall in areas approved by the Owner's Representative.

1.23 AS BUILT RECORD SET OF DRAWINGS

- A. Immediately upon the installation of any buried pipe or equipment, the Contractor shall indicate on the progress record drawings the locations of said pipe or equipment. The progress record drawings shall be made available at any time for review by the Owner's Representative.
- B. Before final acceptance of work, the Contractor shall provide an as built record set of drawings showing the irrigation system work as built. The drawings shall be transmitted to the Owner's Representative in paper format and as a pdf file of each document on compact disk or flash drive. The drawings shall include all information shown on the original contract document and revised to reflect all changes in the work. The drawings shall include the following additional information
 - 1. All valves shall be numbered by station and corresponding numbers shall be shown on the as built record set of drawings.
 - 2. All main line pipe or irrigation equipment including sleeves, valves, controllers, irrigation wire runs which deviate from the mainline location, backflow preventers, remote control valves, grounding rods, shut-off valves, rain sensors, wire splice locations, and quick coupling valves shall be located by two (2) measured dimensions, to the nearest one-half foot. Dimensions shall be given from permanent objects such as buildings, sidewalks, curbs, walls, structures and driveways. All changes in direction and depth of main line pipe shall be noted exactly as installed. Dimensions for pipes shall be shown at no greater than a 50 ft. maximum interval.
 - 3. As built record set of drawings shall be signed and dated by the Contractor attesting to and certifying the accuracy of the as built record set of drawings. As built record set of drawings shall have "As Built Record Set of Drawings", company name, address, phone number and the name of the person who created the drawing and the contact name (if different).
- C. The Owner shall make the original contract drawing files available to the Contractor.

1.24 CONTROLLER CHARTS:

- A. Provide one controller chart for each automatic controller installed.
 - 1. On the inside surface of the cover of each automatic controller, prepare and mount a color-coded chart showing the valves, main line, and systems serviced by that controller. All valves shall be numbered to match the operation schedule and the drawings. Only those areas controlled by that controller shall be shown. This chart shall be a plot plan, entire or partial, showing building, walks, roads and walls. The plan, reduced as necessary and legible in all details, shall be made to a size that will fit into the controller cover. This print shall be approved by the Owner's Representative and shall be protected in laminated in a plastic cover and be secured to the inside back of the controller cabinet door.
 - 2. The controller chart shall be completed and approved prior to acceptance of the work.

1.25 TESTING

- A. Provide all required system testing with written reports as described in part 3.

1.26 OPERATION AND MAINTENANCE MANUALS AND GUARANTEES

- A. Prepare and deliver to the Owner's Representative within ten calendar days prior to completion of construction, two 3-ring hard cover binders containing the following information:
 - 1. Index sheet stating Contractor's address and telephone number, list of equipment with name and addresses of local manufacturers' representatives.
 - 2. Catalog and parts sheets on all material and equipment.

3. Guarantee statement. The start of the guarantee period shall be the date the irrigation system is accepted by the Owner.
 4. Complete operating and maintenance instruction for all major equipment.
 5. Irrigation product manufacturers warranties.
- B. In addition to the above-mentioned maintenance manuals, provide the Owner's maintenance personnel with instructions for maintaining major equipment and show evidence in writing to the Owner's Representative at the conclusion of the project.

PART 2 – PRODUCTS

2.1 MATERIALS GENERAL

- A. All materials shall be of standard, approved and first grade quality and shall be new and in perfect condition when installed and accepted.
- B. See the parts schedule on the drawings for specific components and manufacturers.
- C. Approval of any items or substitutions indicates only that the product(s) apparently meet the requirements of the drawings and specifications on the basis of the information or samples submitted. The Contractor shall be responsible for the performance of substituted items. If the substitution proves to be unsatisfactory or not compatible with other parts of the system, the Contractor shall replace said items with the originally specified items, including all necessary work and modifications to replace the items, at no cost to the owner.

2.2 PIPING MATERIAL

- A. Individual types of pipe and fittings supplied are to be of compatible manufacturer unless otherwise approved. Pipe sizes shown are nominal inside diameter unless otherwise noted.
- B. Plastic pipe:
 1. All pipe shall be free of blisters, internal striations, cracks, or any other defects or imperfections. The pipe shall be continuously and permanently marked with the following information: manufacturer's name or trade mark, size, class and type of pipe pressure rating, quality control identifications, date of extrusion, and National Sanitation Foundation (NSF) rating.
 2. Pressure main line for piping upstream of remote control valves and quick coupling valves:
 - a. Pipe smaller than 2-1/2 inch diameter shall be plastic pipe for use with solvent weld or threaded fittings. Shall be manufactured rigid virgin polyvinyl chloride (PVC) 1220, Type 1, Grade 2 conforming to ASTM D 1785, designated as Schedule 40.
 3. Non-pressure lateral line for piping downstream of remote control valves: plastic pipe for use with solvent weld or threaded fittings. Shall be manufactured rigid virgin polyvinyl chloride PVC 1220 (type 1, grade 2) conforming to ASTM d 1785, designated as Class 200, 1" minimum size.

2.3 FITTINGS AND CONNECTIONS:

- A. Polyvinyl chloride pipe fittings and connections: Type II, Grade 1, Schedule 40, high impact molded fittings, manufactured from virgin compounds as specified for piping tapered socket or molded thread type, suitable for either solvent weld or screwed connections. Machine threaded fittings and plastic saddle and flange fittings are not acceptable. Furnish fittings permanently marked with following information: nominal pipe size, type and schedule of material, and National Sanitation Foundation (NSF) seal of approval. PVC fittings shall conform to ASTM D2464 and D2466.

2.4 SOLVENT CEMENTS AND THREAD LUBRICANT

- A. Solvent cements shall comply with ASTM D2564. Socket joints shall be made per recommended procedures for joining PVC plastic pipe and fittings with PVC solvent cement and primer by the pipe and fitting manufacturer and procedures outlined in the appendix of ASTM D2564.
- B. Thread lubricant shall be Teflon ribbon-type, or approved equal, suitable for threaded installations as per manufacturer's recommendations.

2.5 PRESSURE REGULATOR

- A. Pressure regulator shall be certified to NSF/ANSI 372, consisting of low lead bronze body bell housing, a separate access cap shall be threaded to the body and shall not require the use of ferrous screws.
- B. The main valve body shall be cast bronze (ASTM B 584).
- C. The access covers shall be bronze (ASTM B 584 or Brass ASTM B 16)
- D. The assembly shall be of the balanced piston design and shall reduce the pressure in both flow and no flow conditions.
- E. Pressure regulator shall be as indicated on the drawings.

2.7 BALL VALVES

- A. Ball valves shall be as indicated on the drawings.

2.6 REMOTE CONTROL VALVES

- A. Remote control valves shall be electrically operated, single seat, normally closed configuration, equipped with flow control adjustment and capability for manual operation.
- B. Valves shall be actuated by a normally closed low wattage solenoid using 24 volts, 50/60 cycle solenoid power requirement. Solenoid shall be epoxy encased. A union shall be installed on the discharge end.
- C. Remote control valves shall be wired to controller in same numerical sequence as indicated on drawings.
- D. Remote control valves shall be as indicated on the drawings.

2.7 MASTER CONTROL VALVES

- A. Master control valves shall be as indicated on the drawings.

2.8 QUICK COUPLER VALVES

- A. Quick coupler valves shall be heavy-duty brass construction with a working pressure of 150 PSI with a built in flow control and a self-closing valve.
- B. Quick coupler shall be equipped with locking red brass cap covered with durable yellow thermo-plastic rubber cover. Key size shall be compatible with quick coupler and of same manufacturer.
- C. Quick coupler valves shall be as indicated on the drawings.

2.9 SPRINKLER HEADS

- A. All sprinkler heads shall be as indicated on the drawings.

2.10 AUTOMATIC CONTROLLER

- A. Automatic controller shall be as indicated on the drawings.

2.11 ELECTRICAL CONTROL WIRING

A. Low voltage

1. The electrical control wire shall be direct burial type UF, no. 12 AWG, solid, single conductor, copper wire UL approved or larger, if required to operate system as designed.
2. The electrical common white wire shall be direct burial type UF, no. 10 AWG, solid, single conductor, copper wire UL approved or larger, if required to operate system as designed.
3. Color code wires to each valve.
4. Control wire splices: Splices are when required shall be placed in splice boxes.
5. Wire connections shall be per the controller manufacturer's specifications and recommendations.

2.12 VALVE BOXES AND MATERIALS

- A. Valve boxes: valve boxes shall be constructed of ABS (acrylonitrile butadiene styrene) plastic with rigid base and sides and shall be supplied with bolt lock cover secured with stainless steel bolts. Cover shall be identified as shown on drawings. Provide box extensions as required.
 1. Master valves, flow sensors, remote control irrigation valves and gate valves shall use a 14 inch x 19 inch x 12 inch rectangular box.
 2. Quick coupler valves and wire splices shall use a 10 inch circular box.

2.13 VALVE IDENTIFICATION TAGS

- A. Valve Identification Tags shall be 2.25 inch x 2.65 inch polyurethane. Color: potable water; yellow / Non-potable water; purple. Tags shall be permanently attached to each remote control valve with tamper proof seals as indicated on the drawings.

2.14 EQUIPMENT TO BE FURNISHED TO OWNER

- A. Two (2) sets of keys for each automatic controller.
- B. Two (2) 48 inch tee wrenches for operating the gate valves.
- C. Three (3) sets of special tools required for removing, disassembling and adjusting each type of sprinkler and valve supplied on this project.
- D. Five (5) Extra sprinkler heads, nozzles, shrub adapters, nozzle filter screens, for each type used on the project.
- E. Two (2) quick coupler keys to match manufacturer type of quick coupler.

2.15 INCIDENTAL MATERIALS AND EQUIPMENT

- A. Furnish all materials and equipment not specified above, but which are necessary for completion of the work as intended.

2.16 MAIN LINE LOCATOR TAPE

- A. 3 - inch wide plastic detectable locator tape.

2.17 MAIN LINE AND LATERAL LINE BEDDING SAND

- A. Sand shall consist of natural or manufactured granular material, free of organic material, mica, loam, clay or other substances not suitable for the intended purpose.
- B. Sand shall be masonry sand ASTM C 144 or coarse concrete sand, ASTM C 33.

PART 3 – EXECUTION

3.1 GENERAL REQUIREMENTS

- A. Code requirements shall be those of state and municipal codes and regulations locally governing this work, providing that any requirements of the drawings and specifications, not conflicting therewith, but exceeding the code requirements, shall govern unless written permission to the contrary is granted by the Owner's Representative.
- B. Extreme care shall be exercised at all times by the Contractor in excavating and working in the project area due to existing utilities and irrigation systems to remain. Contractor shall be fully responsible for expenses incurred in the repair of damages caused by their operation.
 - 1. The Contractor is responsible for identifying and maintaining existing irrigation main lines that supply water to areas on the site as noted on the drawings and outside of the proposed limit of work. The Contractor shall relocate or replace existing irrigation main line piping as required to provide a continuous supply of water to all areas of existing irrigation on site.
 - a. Providing continuous water supply shall include hand watering and or the use of watering trucks to provide adequate water.
- C. Plan locations of valves, controllers, irrigation lines, sleeves, spray heads and other equipment are diagrammatic and indicate the spacing and relative locations of all installations. Final site conditions and existing and proposed plantings shall determine final locations and adjusted as necessary and as directed to meet existing and proposed conditions and obtain complete water coverage. Minor changes in locations of the above from locations shown shall be made as necessary to avoid existing and proposed trees, piping, utilities, structures, etc. at the Contractor's expense or when directed by the Owner's Representative.
 - 1. The Contractor shall be held responsible for relocation of any items without first obtaining the Owner's Representative's approval. The Contractor shall remove and relocate such items at their expense if so directed by the Owner's Representative.
- D. Prior to any work the Contractor shall stake out locations of all pipe, valves, equipment and irrigation heads and emitters using an approved staking method and maintain the staking of the approved layout in accordance with the drawings and any required modifications. Verify all horizontal and vertical site dimensions prior to staking of heads. Do not exceed spacing shown on drawings for any given area. If such modified spacing demand additional or less material than shown on the drawings, notify the Owner's Representative before beginning any work in the adjacent area.
- E. Stub out main line at all end runs and as shown on drawings. Stub out wires for future connection where indicated on plan and as directed.
- F. Point of connection shall be approximately as shown on drawings. Connect new underground piping and valves and provide all flanges, adapters or other necessary fittings for connection.
- G. Permission to shut off any existing in-use water line must be obtained 48 hours in advance, in writing from the Owner. The Contractor shall receive instructions from the Owner's Representative as to the exact length of time of each shut-off.
- H. No fittings shall be installed on pipe underneath pavement or walls.
- I. Prior to starting any work, Contractor shall obtain a reading of existing static water pressure (no flow

condition) at the designated point of connection and immediately submit written verification of pressure with date and time of recording to Owner's Representative.

3.2 TRENCHING, DIRECTIONAL BORING AND SLEEVING

- A. Perform all trenching, directional boring, sleeving and excavations as required for the installation of the work included under this section, including shoring of earth banks to prevent cave-ins.
- B. The Contractor may directional bore lines where it is practical or where required on the plans.
 - 1. Extend the bore 18 inches past the edge of pavement unless noted differently on the plans
 - 2. Cap ends of each bore and locate ends at finished grade using metal stakes.
 - 3. All boring and sleeving shall have detectable locator tape placed at the ends of the pipe.
- C. Make trenches for mains, laterals and control wiring straight and true to grade and free of protruding stones, roots or other material that would prevent proper bedding of pipe or wire.
- D. Excavate trenches wide enough to allow a minimum of 4 inch between parallel pipelines and 8 inch from lines of other trades. Maintain 3 inch vertical clearance between irrigation lines. Minimum transverse angle is 45 degrees. All pipes shall be able to be serviced or replaced without disturbing the other pipes.
- E. Trenches for pipelines shall be made of sufficient depth to provide the minimum cover from finished grade as follows:
 - 1. Pressure main line: 18 inches below finish grade and 24 inches below paved areas in Schedule 40 PVC sleeves.
 - 2. Lateral lines: 12 inches below finish grade and 18 inches below paved areas in Schedule 40 PVC sleeves.
 - 3. Control wiring: to the side of pressure main line and 24 inches below paved areas in Schedule 40 PVC sleeves.
- F. On new on-site systems (post-meter), the required horizontal separation between potable water lines and sewer lines shall be a minimum of four (4) feet apart as directed by the project engineer and/ or regulatory agency. Measurements shall be between facing surfaces, not pipe centerlines.
- G. When trenching through areas of imported or modified soil, deposit imported or modified soils on one side of trench and subsoil on opposite side. Dispose of excess trench spoils legally off site.
- H. Backfill the trench per the requirements in paragraphs "Backfilling and Compacting" below.

3.3 PIPE INSTALLATION

- A. General Pipe Installation
 - 1. Exercise caution in handling, loading and storing, of plastic pipe and fittings to avoid damage.
 - a. The pipe and fittings shall be stored under cover until using, and shall be transported in a vehicle with a bed long enough to allow the length of pipe to lay flat so as not to be subjected to undue bending or concentrated external load at any point.
 - b. All pipe that has been dented or damaged shall be discarded unless such dent or damaged section is cut out and pipe rejoined with a coupling.
 - 2. Trench depth shall be as specified above from the finish grade to the top of the pipe.
 - 3. Install a detectable pipe locator tape 6 to 8 inches above all main line pipes.
- B. Polyvinyl Chloride Pipe (PVC) Installation

1. Under no circumstance is pipe to rest on concrete, rock, wood blocks, construction debris or similar items.
2. No water shall be permitted in the pipe until a period of at least 24 hours has elapsed for solvent weld setting and curing.
3. Install assemblies and pipe to conform to respective details and where shown diagrammatically on drawings, using first class workmanship and best standard practices as approved. All fittings that are necessary for proper connections such as swing joints, offsets, and reducing bushings that are not shown on details shall be installed as necessary and directed as part of the work.
4. Dielectric bushings shall be used in any connections of dissimilar metals.
5. Solvent weld or threaded plastic pipe:
 - a. Installation of all pipe and fittings shall be in strict accordance with manufacturer's specifications.
 - b. Pipe shall be cut using approved PVC pipe cutters only. Sawed joints are disallowed. All field cuts shall be beveled to remove burrs and excess before gluing.
 - c. Welded joints shall be given a minimum of 15 minutes to set before moving or handling. Excess solvent on the exterior of the joint shall be wiped clean immediately after assembly.
 - d. Plastic to metal connections shall be made with plastic adapters and if necessary, short (not close) brass threaded-nipples. Connection shall be made with two (2) wraps of Teflon tape and hand tightened plus one turn with a strap wrench.
 - e. Snake pipe horizontally in trench to allow one (1) foot of expansion and contraction per 100 feet of straight run.
 - f. Threaded pipe joints shall be made using Teflon tape. Solvent shall not be used with threaded joints. Pipe shall be protected from tool damage during assembly. All damaged pipe shall be removed and replaced. Take up threaded joints with light wrench pressure.
 - g. No close nipples or risers are allowed. Cross connections in piping is disallowed.
 - h. Center load pipe at 10 feet on center intervals with small amount of backfill to prevent arching and slipping under pressure. Other than this preliminary backfill all pipe joints, fittings and connections are to remain uncovered until successful completion of hydrostatic testing and written approval of the testing report.

3.4 TRENCHING, DIRECTIONAL BORING, AND SLEEVING REVIEW:

- A. Upon completion and installation of all trenching, directional boring, and sleeving, all installed irrigation control wiring, lines and fittings shall be visually observed by the Owner's Representative unless otherwise authorized. Do not cover any wires, lines or fittings until they have been tested and observed by the Owner's Representative.

3.5 FLUSHING

- A. Openings in piping system during installation are to be capped or plugged to prevent dirt and debris from entering pipe and equipment. Remove plugs when necessary to flush or complete system.
- B. After completion and prior to the installation of any terminal fittings, the entire pipeline system shall be thoroughly flushed to remove dirt, debris or other material.

3.6 HYDROSTATIC PRESSURE TESTING

- A. After flushing, and the installation of valves the following tests shall be conducted in the sequence listed below. The Contractor shall furnish all equipment; materials and labor necessary to perform the tests and all tests shall be conducted in the presence of the Owner's Representative.
- B. Water pressure tests shall be performed on all pressure main lines before any couplings, fittings, valves and the like are concealed.

- C. Immediately prior to testing, all irrigation lines shall be purged of all entrapped air or debris by adjusting control valves and installing temporary caps forcing water and debris to be discharged from a single outlet.
- D. Test all pressure main line at 150 PSI. For a minimum of four (4) hours with an allowable loss of 5 PSI. Pressure and gauges shall be read in PSI, and calibrated such that accurate determination of potential pressure loss can be ascertained.
- E. Re-test as required until the system meets the requirements. Any leaks, which occur during test period, will be repaired immediately following the test. All pipe shall be re-tested until final written acceptance.
- F. The Contractor is responsible for proving documentation stating the weather conditions, date, the start time and initial water pressure readings, the finish time and final water pressure readings and the type of equipment used to perform the test. The documentation must be signed by a witness acceptable to the Owner, verifying all of the above-mentioned conditions.
- G. Submit a written report of the pressure testing results with the other above required information to the Owner's Representative for approval.

3.7 BACKFILLING AND COMPACTING

- A. Irrigation trenches shall be carefully backfilled with material approved for backfilling and free of rocks and debris one (1) inch in diameter and larger. When back filling trenches in areas of imported or modified planting soil, replace any excavated subsoil at the bottom and the imported soil or modified planting soil at the top of the trench.
- B. Backfill shall be compacted with approved equipment to the following densities
 - 1. Backfill under pavement and within 2 feet of the edge of pavement: Compact to 95% or greater of maximum dry density standard proctor.
 - 2. Backfill of subsoil under imported planting mixes or modified existing planting soil: Between 85 and 90% of maximum dry density standard proctor.
 - 3. Backfill of imported planting mixes or modified existing planting soil: Compact to the requirements of the adjacent planting mix or planting soil as specified in section "Planting Soil".
- C. Finish grade of all trenches shall conform to adjacent grades without dips or other irregularities. Dispose of excess soil or debris off site at Contractor's expense.
- D. Any settling of backfill material during the maintenance or warranty period shall be repaired at the Contractor's expense, including any replacement or repair of soil, lawn, and plant material or paving surface.

3.8 RESURFACING PAVING OVER TRENCHES

- A. Restore all surfaces and repair existing underground installations damaged or cut as a result of the excavation to their original condition, satisfactory to the Owner's Representative.
- B. Trenches through paved areas shall be resurfaced with same materials quality and thickness as existing material. Paving restoration shall be performed by the project paving Sub-contractor or an approved Contractor skilled in paving work.
- C. The cost of all paving restoration work shall be the responsibility of the irrigation Contractor unless the trenching thru the paving was, by previous agreement, part of the general project related construction.

3.9 INSTALLATION OF EQUIPMENT

- A. General:

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1. All equipment shall be installed to meet all installation requirements of the product manufacturer. In the event that the manufactures requirements cannot be implemented due to particular condition at the site or with other parts of the design, obtain the Owner's Representative's written authorization and approval for any modifications.
 2. Install all equipment at the approximately at the location(s) and as designated and detailed on the drawings. Verify all locations with the Owner's Representative.
 3. Install all valves within a valve box of sufficient size to accommodate the installation and servicing of the equipment. Group valves together where practical and locate in shrub planting areas.
 4. All sprinkler irrigation systems that are using water from potable water systems shall require backflow prevention. All backflow prevention devices shall meet and be installed in accordance with requirements set forth by local codes and the health department.
- B. Pressure regulator:
1. Set regulator for required PSI per manufacturer's specifications.
- C. Remote control valves:
1. Install one remote control valve per valve box.
 2. Remote control valve manifolds and quick coupler valves shall be separate allowing use of a quick coupler with all remote control valves shut off.
 3. Install boxes no farther than 12 inches from edge of paving and perpendicular to edge of paving and parallel to each other. Allow 12 inches clearance between adjacent valve boxes.
- D. Quick coupler valve:
1. Install each quick coupler valve in its own valve box.
 2. Place no closer than 12 inches to adjacent paving.
 3. Install 18 inches off set from main line.
- E. Sprinkler heads:
1. All main lines and lateral lines, including risers, shall be flushed and pressure tested before installing sprinkler heads.
 2. Install specified sprinkler heads as shown in details at locations shown on the drawings. Adjust layout for full coverage, spacing of heads shall not exceed the maximum spacing recommended by the manufacturer.
 3. All sprinkler heads shall be set perpendicular to finish grade unless otherwise designated on the drawings or details.
- F. Irrigation controllers:
1. Remote control valves shall be connected to controller in numerical sequence as shown on the drawings.
 2. Controller shall be tested with complete electrical connections. The Contractor shall be responsible for temporary power to the controller for operation and testing purposes.
 3. Connections to control wiring shall be made within the pedestal of the controller. All wire shall follow the pressure main insofar as possible.
 4. Electrical wiring shall be in a rigid gray PVC plastic conduit from controller to electrical outlet. The electrical Contractor shall be responsible for installing all wiring to the controller, in order to complete this installation. A disconnect switch shall be included.

G. Wiring:

1. Low Voltage

- a. Control wiring between controller and electrical valves shall be installed in the same trench as the main line where practical. The wire shall be bundled and secured to the lower quadrant of the trench at 10 foot intervals with plastic electrical tape.
- b. When the control wiring cannot be installed in the same main line trench it shall be installed a minimum of 18 inches below finish grade and a bright colored plastic ribbon with suitable markings shall be installed in the trench 6 inches below grade directly over the wire.
- c. An expansion loop shall be provided every 500 feet in a box and inside each valve box. Expansion loop shall be formed by wrapping wire at least eight (8) times around a ¾ inch pipe and withdrawing pipe.
- d. Provide one control wire to service each valve in system.
- e. Provide one common wire(s) per controller.
- f. Run two (2) spare #12-1 wires from controller along entire main line to last electric remote control valve on each and every leg of main line. Label spare wires at controller and wire stub to be located in a box.
- g. All control wire splices not occurring at control valve shall be installed in a separate splice valve box.
- h. Wire markers (sealed, 1 inch to 3 inch square) are to identify control wires at valves and at terminal strips of controller. At the terminal strip mark each wire clearly indicating valve circuit number.

2. High Voltage

- a. All electrical work shall conform to local codes, ordinances and any authorities having jurisdiction. All high voltage electrical work to be performed by licensed electrician.
- b. The Contractor shall provide 120-volt power connection to the automatic controller unless noted otherwise on drawings.

H. Valve boxes:

1. Install one valve box for each type of valve installed as per the details.
2. Gravel sump shall be installed after compaction of all trenches. Final portion of gravel shall be placed inside valve box after valve is backfilled and compacted.
3. Permanently label valve number and or controller letter on top of valve box lid using a method approved by the Owners Representative.

I. Tracer wire:

1. Tracer wire shall be installed with non-metallic plastic irrigation main lines where controller wires are not buried in the same trench as the main line.
2. The tracer wire shall be placed on the bottom of the trench under the vertical projection of the pipe with spliced joints soldered and covered with insulation type tape.
3. Tracer wire shall be of a color not used for valve wiring. Terminate wire in a valve box. Provide enough length of wire to make a loop and attach wire marker with the designation "tracer wire".

3.10 ADJUSTMENT AND COVERAGE TEST

A. Adjustment:

1. The Contractor shall flush and adjust all sprinkler heads, valves and all other equipment to ascertain that they function according to the manufacturer's data.
2. Adjust all sprinkler heads not to overspray onto walks, roadways and buildings when under maximum operating pressure and during times of normal prevailing winds.

B. Coverage test:

1. The Contractor shall perform the coverage test in the presence of the Owner's Representative after all sprinkler heads have been installed, flushed and adjusted. Each section is tested to demonstrate uniform and adequate coverage of the planting areas serviced.
2. Any systems that require adjustments for full and even coverage shall be done by the Contractor prior to final acceptance at the direction of the Owner's Representative at no additional cost. Adjustments may also include realignment of pipes, addition of extra heads, and changes in nozzle type or size.
3. The Contractor at no additional cost shall immediately correct all unauthorized changes or improper installation practices.
4. The entire irrigation system shall be operating properly with written approval of the installation by the Owner's representative prior to beginning any planting operations.

3.11 REPAIR OF PLANTING SOIL

- A. Any areas of planting soil including imported or existing soils or modified planting soil which become compacted or disturbed or degraded as a result of the installation of the irrigation system shall be restored to the specified quality and compaction prior to beginning planting operations at no additional expense to the Owner. Restoration methods and depth of compaction remediation shall be approved by the Owner's Representative.

3.12 CLEAN-UP

- A. During installation, keep the site free of trash, pavements reasonably clean and work area in an orderly condition at the end of each day. Remove trash and debris in containers from the site no less than once a week.
- a. Immediately clean up any spilled or tracked soil, fuel, oil, trash or debris deposited by the Contractor from all surfaces within the project or on public right of ways and neighboring property.
- B. Once installation is complete, wash all soil from pavements and other structures.
1. Make all repairs to grades ruts, and damage to the work or other work at the site.
 2. Remove and dispose of all excess soil, packaging, and other material brought to the site by the Contractor.

3.13 PROTECTION

- A. The Contractor shall protect installed irrigation work from damage due to operations by other Contractors or trespassers.
1. Maintain protection during installation until Acceptance. Treat, repair or replace damaged work immediately. The Owner's Representative shall determine when such treatment, replacement or repair is satisfactory.

3.14 PRE-MAINTENANCE OBSERVATION:

- A. Once the entire system shall be completely installed and operational and all planting is installed, the Owner's Representative shall observe the system and prepare a written punch list indicating all items to be corrected and the beginning date of the maintenance period.
- B. This is not final acceptance and does not relieve the Contractor from any of the responsibilities in the contract documents.

3.15 GENERAL MAINTENANCE AND THE MAINTENANCE PERIOD

- A. General maintenance shall begin immediately after installation of irrigation system. The general maintenance and the maintenance period shall include the following:
 - 1. On a weekly basis the Contractor shall keep the irrigation system in good running order and make observations on the entire system for proper operation and coverage. Repair and cleaning shall be done to keep the system in full operation.
 - 2. Records of all timing changes to control valves from initial installation to time of final acceptance shall be kept and turned over to the Owner's Representative at the time of final acceptance.
 - 3. During the last week of the maintenance period, provide equipment familiarization and instruction on the total operations of the system to the personnel who will assume responsibility for running the irrigation system.
 - 4. At the end of the maintenance period, turn over all operations logs, manuals, instructions, schedules, keys and any other equipment necessary for operation of the irrigation system to the Owner's Representative who will assume responsibility for the operations and maintenance of the irrigation system.
- B. The maintenance period for the irrigation system shall coincide with the maintenance period for the Planting. (See specification section "Planting")

3.16 SUBSTANTIAL COMPLETION ACCEPTANCE

- A. Upon written notice from the Contractor, the Owners Representative shall review the work and make a determination if the work is substantially complete.
- B. The date of substantial completion of the irrigation shall be the date when the Owner's Representative accepts that all work in Planting, Planting Soil, and Irrigation installation sections is complete.

3.17 FINAL ACCEPTANCE / SYSTEM MALFUNCTION CORRECTIONS

- A. At the end of the Plant Warrantee and Maintenance period, (See specification section "Planting") the Owner's Representative shall inspect the irrigation work and establish that all provisions of the irrigation system are complete and the system is working correctly.
 - 1. Restore any soil settlement over trenches and other parts of the irrigation system.
 - 2. Replace, repair or reset any malfunctioning parts of the irrigation system.
- B. The Contractor shall show all corrections made from punch list. Any items deemed not acceptable shall be reworked and the maintenance period will be extended.
- C. The Contractor shall show evidence that the Owner's Representative has received all charts, records, drawings, and extra equipment as required before final acceptance.
- D. Failure to pass review: If the work fails to pass final review, any subsequent observations must be rescheduled as per above. The cost to the Owner for additional observations will be charged to the Contractor at the prevailing hourly rate of the reviewer.

END OF SECTION 32 8400

SECTION 32 9113
SOIL PREPARATION

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 planting soils specified by composition of the mixes.
- B. Related Requirements:
 - 1. Section 329200 "Turf and Grasses" for placing planting soil for turf and grasses.
 - 2. Section 329300 "Plants" for placing planting soil for plantings.

1.3 DEFINITIONS

- A. AAPFCO: Association of American Plant Food Control Officials.
- B. Backfill: The earth used to replace or the act of replacing earth in an excavation. This can be amended or unamended soil as indicated.
- C. CEC: Cation exchange capacity.
- D. Compost: The product resulting from the controlled biological decomposition of organic material that has been sanitized through the generation of heat and stabilized to the point that it is beneficial to plant growth.
- E. Duff Layer: A surface layer of soil, typical of forested areas, that is composed of mostly decayed leaves, twigs, and detritus.
- F. Imported Soil: Soil that is transported to Project site for use.
- G. Manufactured Soil: Soil produced by blending soils, sand, stabilized organic soil amendments, and other materials to produce planting soil.
- H. NAPT: North American Proficiency Testing Program. An SSSA program to assist soil-, plant-, and water-testing laboratories through interlaboratory sample exchanges and statistical evaluation of analytical data.
- I. Organic Matter: The total of organic materials in soil exclusive of undecayed plant and animal tissues, their partial decomposition products, and the soil biomass; also called "humus" or "soil organic matter."

- J. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified as specified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.
- K. RCRA Metals: Hazardous metals identified by the EPA under the Resource Conservation and Recovery Act.
- L. SSSA: Soil Science Society of America.
- M. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.
- N. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.
- O. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil"; but in disturbed areas such as urban environments, the surface soil can be subsoil.
- P. USCC: U.S. Composting Council.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include recommendations for application and use.
 - 2. Include test data substantiating that products comply with requirements.
 - 3. Include sieve analyses for aggregate materials.
 - 4. Material Certificates: For each topsoil and growing medium stockpile before delivery to the site, according to the following:
 - a. Manufacturer's qualified testing agency's certified analysis of standard products.
 - b. Analysis of fertilizers, by a qualified testing agency, made according to AAPFCO methods for testing and labeling and according to AAPFCO's SU1P #25.
 - c. Analysis of nonstandard materials, by a qualified testing agency, made according to SSSA methods, where applicable.
- B. Samples: For each bulk-supplied material, 1-quart volume of each in sealed containers labeled with content, source, and date obtained. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of composition, color, and texture.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For each testing agency.
- B. Preconstruction Test Reports: For preconstruction soil analyses specified in "Preconstruction Testing" Article.
- C. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent, state-operated, or university-operated laboratory; experienced in soil science, soil testing, and plant nutrition; with the experience and capability to conduct the testing indicated; and that specializes in types of tests to be performed.
 - 1. Multiple Laboratories: At Contractor's option, work may be divided among qualified testing laboratories specializing in physical testing, chemical testing, and fertility testing.

1.7 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction soil analyses on existing, on-site soil and any imported soils.
 - 1. Notify Owner and General Contractor seven days in advance of the dates and times when laboratory samples will be taken.
- B. Preconstruction Soil Analyses: For each unamended soil type, perform testing on soil samples and furnish soil analysis and a written report containing soil-amendment and fertilizer recommendations by a qualified testing agency performing the testing according to "Soil-Sampling Requirements" and "Testing Requirements" articles.
 - 1. Have testing agency identify and label samples and test reports according to sample collection and labeling requirements.

1.8 SOIL-SAMPLING REQUIREMENTS

- A. General: Extract soil samples according to requirements in this article.
- B. Sample Collection and Labeling: Have samples taken and labeled by contractor.
 - 1. Number and Location of Samples: Minimum of one representative soil samples for each soil to be used or amended for landscaping purposes.
 - 2. Division of Samples: Split each sample into two, equal parts. Send half to the testing agency and half to Landscape Architect for review and records.
 - 3. Labeling: Label each sample with the date, location keyed to a site plan or other location system, visible soil condition, and sampling depth.

1.9 TESTING REQUIREMENTS

- A. General: Perform tests on soil samples according to requirements in this article.
- B. Physical Testing:
 - 1. Soil Texture: Soil-particle, size-distribution analysis by one of the following methods according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods":

- a. Sieving Method: Report sand-gradation percentages for very coarse, coarse, medium, fine, and very fine sand; and fragment-gradation (gravel) percentages for fine, medium, and coarse fragments; according to USDA sand and fragment sizes.
 - b. Hydrometer Method: Report percentages of sand, silt, and clay.
 2. Total Porosity: Calculate using particle density and bulk density according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."
 3. Water Retention: According to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."
 4. Saturated Hydraulic Conductivity: According to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods"; at 85% compaction according to ASTM D 698 (Standard Proctor).
- C. Chemical Testing:
1. CEC: Analysis by sodium saturation at pH 7 according to SSSA's "Methods of Soil Analysis - Part 3- Chemical Methods."
 2. Clay Mineralogy: Analysis and estimated percentage of expandable clay minerals using CEC by ammonium saturation at pH 7 according to SSSA's "Methods of Soil Analysis - Part 1- Physical and Mineralogical Methods."
 3. Metals Hazardous to Human Health: Test for presence and quantities of RCRA metals including aluminum, arsenic, barium, copper, cadmium, chromium, cobalt, lead, lithium, and vanadium. If RCRA metals are present, include recommendations for corrective action.
 4. Phytotoxicity: Test for plant-available concentrations of phytotoxic minerals including aluminum, arsenic, barium, cadmium, chlorides, chromium, cobalt, copper, lead, lithium, mercury, nickel, selenium, silver, sodium, strontium, tin, titanium, vanadium, and zinc.
- D. Fertility Testing: Soil-fertility analysis according to standard laboratory protocol including the following:
1. Percentage of organic matter.
 2. CEC, calcium percent of CEC, and magnesium percent of CEC.
 3. Soil reaction (acidity/alkalinity pH value).
 4. Buffered acidity or alkalinity.
 5. Nitrogen ppm.
 6. Phosphorous ppm.
 7. Potassium ppm.
 8. Manganese ppm.
 9. Manganese-availability ppm.
 10. Zinc ppm.
 11. Zinc availability ppm.
 12. Copper ppm.
 13. Sodium ppm and sodium absorption ratio
 14. Soluble-salts ppm.
 15. Presence and quantities of problem materials including salts and metals cited in the Standard protocol. If such problem materials are present, provide additional recommendations for corrective action.
 16. Other deleterious materials, including their characteristics and content of each.

- E. Organic-Matter Content: Analysis using loss-by-ignition method according to SSSA's "Methods of Soil Analysis - Part 3- Chemical Methods."
- F. Recommendations: Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated to produce satisfactory planting soil suitable for healthy, viable plants indicated. Include, at a minimum, recommendations for nitrogen, phosphorous, and potassium fertilization, and for micronutrients.
 - 1. Fertilizers and Soil Amendment Rates: State recommendations in weight per 1000 sq. ft.
 - 2. Soil Reaction: State the recommended liming rates for raising pH or sulfur for lowering pH according to the buffered acidity or buffered alkalinity in weight per 1000 sq. ft.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and compliance with state and Federal laws if applicable.
- B. Bulk Materials:
 - 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
 - 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
 - 3. Do not move or handle materials when they are wet or frozen.
 - 4. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.

PART 2 - PRODUCTS

2.1 PLANTING SOILS SPECIFIED BY COMPOSITION

- A. General: Soil amendments, fertilizers, and rates of application specified in this article are guidelines that may need revision based on testing laboratory's recommendations after preconstruction soil analyses are performed.
- B. Planting-Soil Existing: On-site surface soil, with the duff layer, if any, retained and stockpiled on-site; modified to produce viable planting soil. Blend existing, on-site surface soil with the following soil amendments and fertilizers based on the soils lab recommendations.
- C. Planting-Soil Imported: Imported, naturally formed soil from off-site sources and consisting of sandy loam soil according to USDA textures; and modified to produce viable planting soil.
 - 1. Sources: Take imported, unamended soil from sources that are naturally well-drained sites where topsoil occurs at least 4 inches deep, not from agricultural land, bogs, or marshes; and that do not contain undesirable organisms; disease-causing plant pathogens; or obnoxious weeds and invasive plants including, but not limited to, quackgrass,

Johnsongrass, poison ivy, nutsedge, nimblewill, Canada thistle, bindweed, bentgrass, wild garlic, ground ivy, perennial sorrel, and brome grass.

2. Unacceptable Properties: Clean soil of the following:
 - a. Unacceptable Materials: Concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.
 - b. Unsuitable Materials: Stones, roots, plants, sod, clay lumps, and pockets of coarse sand that exceed a combined maximum of 8 percent by dry weight of the imported soil.
 - c. Large Materials: Stones, clods, roots, clay lumps, and pockets of coarse sand exceeding 2 inches in any dimension.

2.2 INORGANIC SOIL AMENDMENTS

- A. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:
- B. Sulfur: Granular, biodegradable, and containing a minimum of 90 percent elemental sulfur, with a minimum of 99 percent passing through a No. 6 sieve and a maximum of 10 percent passing through a No. 40 sieve.
- C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.
- D. Perlite: Horticultural perlite, soil amendment grade.
- E. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through a No. 50 sieve.
- F. Sand: Clean, washed, natural or manufactured, free of toxic materials.

2.3 ORGANIC SOIL AMENDMENTS

- A. Compost: Well-composted, stable, and weed-free organic matter produced by composting feedstock, and bearing USCC's "Seal of Testing Assurance," and as follows:
 1. Feedstock: Limited to leaves.
 2. Reaction: pH of 5.5 to 8.
 3. Soluble-Salt Concentration: Less than 4 dS/m.
 4. Moisture Content: 35 to 55 percent by weight.
 5. Organic-Matter Content: 30 to 40 percent of dry weight.

2.4 FERTILIZERS

- A. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of [20] [33] [50] percent available phosphoric acid.

- B. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
 - 1. Composition: 1 lb/1000 sq. ft. of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.
 - 2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified testing agency.
- C. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
 - 1. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.
 - 2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified testing agency.
- D. Chelated Iron: Commercial-grade FeEDDHA for dicots and woody plants, and commercial-grade FeDTPA for ornamental grasses and monocots.

PART 3 - EXECUTION

3.1 GENERAL

- A. Place planting soil and fertilizers according to requirements in other Specification Sections.
- B. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in planting soil.
- C. Proceed with placement only after unsatisfactory conditions have been corrected.

3.2 PROTECTION

- A. Protection Zone: Identify protection zones according to Section 015639 "Temporary Tree and Plant Protection."
- B. Protect areas of in-place soil from additional compaction, disturbance, and contamination. Prohibit the following practices within these areas except as required to perform planting operations:
 - 1. Storage of construction materials, debris, or excavated material.
 - 2. Parking vehicles or equipment.
 - 3. Vehicle traffic.
 - 4. Foot traffic.
 - 5. Erection of sheds or structures.
 - 6. Impoundment of water.
 - 7. Excavation or other digging unless otherwise indicated.

- C. If planting soil or subgrade is overcompacted, disturbed, or contaminated by foreign or deleterious materials or liquids, remove the planting soil and contamination; restore the subgrade as directed by Architect and replace contaminated planting soil with new planting soil.

3.3 CLEANING

- A. Protect areas adjacent to planting-soil preparation and placement areas from contamination. Keep adjacent paving and construction clean and work area in an orderly condition.
- B. Remove surplus soil and waste material including excess subsoil, unsuitable materials, trash, and debris and legally dispose of them off Owner's property unless otherwise indicated.
 - 1. Dispose of excess subsoil and unsuitable materials on-site where directed by Owner.

END OF SECTION 329113

SECTION 32 9200
TURF AND GRASSES

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. Seeding.
2. Hydroseeding.
3. Sodding.
4. Plugging.
5. Sprigging.
6. Meadow grasses and wildflowers.
7. Turf renovation.
8. Erosion-control material(s).
9. Grass paving.

B. Related Requirements:

1. Section 329300 "Plants" for trees, shrubs, ground covers, and other plants as well as border edgings and mow strips.
2. Section 334600 "Subdrainage" for below-grade drainage of landscaped areas.

1.3 DEFINITIONS

- A. Finish Grade: Elevation of finished surface of planting soil.
- B. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.
- C. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
- D. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See and drawing designations for planting soils.

- E. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For landscape Installer.
- B. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture, stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.
 - 1. Certification of each seed mixture. Include identification of source and name and telephone number of supplier.
- C. Product Certificates: For fertilizers, from manufacturer.
- D. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of seeded areas during a calendar year. Submit before expiration of required maintenance periods.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful seeded area establishment.
 - 1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
 - 2. Experience: Three years of experience in turf installation in addition to requirements in Section 014000 "Quality Requirements."
 - 3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
 - 4. Personnel Certifications: Installer's field supervisor and one personnel assigned to the Work shall have certification in one of the following categories from the Professional Landcare Network:
 - a. Landscape Industry Certified Technician - Exterior.
 - b. Landscape Industry Certified Lawncare Manager.
 - c. Landscape Industry Certified Lawncare Technician.
 - 5. Pesticide Applicator: State licensed, commercial.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws, as applicable.
- B. Bulk Materials:
 - 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
 - 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
 - 3. Accompany each delivery of bulk materials with appropriate certificates.

1.8 FIELD CONDITIONS

- A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of planting.
 - 1. Spring Planting: After April 15th.
 - 2. Fall Planting: Before September 30th.
- B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 SEED

- A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Rules for Testing Seeds" for purity and germination tolerances.
- B. Seed Species:
 - 1. Quality: State-certified seed of grass species as listed below for solar exposure.
 - 2. Quality: Seed of grass species as listed below for solar exposure, with not less than 95 percent germination, not less than 95% percent pure seed, and not more than 0.5 percent weed seed:

2.2 FERTILIZERS

- A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

1. Composition: 1 lb/1000 sq. ft. of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.
 2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.
- B. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
1. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.
 2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

2.3 MULCHES

- A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.
- B. Compost Mulch: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch sieve; soluble salt content of 2 to 5 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
1. Organic Matter Content: 30-40 percent of dry weight.
 2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.
- C. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic and free of plant-growth or germination inhibitors; with a maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.
- D. Non-asphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.

2.4 PESTICIDES

- A. General: Pesticide, registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.
- B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
- C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to be planted for compliance with requirements and other conditions affecting installation and performance of the Work.
 - 1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
 - 2. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
 - 3. Uniformly moisten excessively dry soil that is not workable or which is dusty.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

3.2 PREPARATION

- A. Protect structures; utilities; sidewalks; pavements; and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
 - 1. Protect adjacent and adjoining areas from hydroseeding and hydromulching overspray.
 - 2. Protect grade stakes set by others until directed to remove them.
- B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 SEEDING

- A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph.
 - 1. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
 - 2. Do not use wet seed or seed that is moldy or otherwise damaged.
 - 3. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.
- B. Sow seed at a total rate of 5 lb/1000 sq. ft.
- C. Rake seed lightly into top 1/8 inch of soil, roll lightly, and water with fine spray.

3.4 HYDROSEEDING

- A. Hydroseeding: Mix specified seed and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.
 - 1. Mix slurry with non-asphaltic fiber-mulch manufacturer's recommended tackifier.
 - 2. Spray-apply slurry uniformly to all areas to be seeded in a one-step process. Apply slurry at a rate so that mulch component is deposited at not less than 1500-lb/acre dry weight, and seed component is deposited at not less than the specified seed-sowing rate.
 - 3. Spray-apply slurry uniformly to all areas to be seeded in a two-step process. Apply first slurry coat at a rate so that mulch component is deposited at not less than 500-lb/acre dry weight, and seed component is deposited at not less than the specified seed-sowing rate. Apply slurry cover coat of fiber mulch (hydromulching) at a rate of 1000 lb/acre.

3.5 PESTICIDE APPLICATION

- A. Apply pesticides and other chemical products and biological control agents according to requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.
- B. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

3.6 CLEANUP AND PROTECTION

- A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- B. Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Owner's property.
- C. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.
- D. Remove nondegradable erosion-control measures after grass establishment period.

3.7 MAINTENANCE SERVICE

- A. Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in "Turf Maintenance" Article. Begin maintenance immediately after each area is planted and continue until acceptable turf is established, but for not less than the following periods:
 - 1. Seeded Turf: One year from date of planting completion.

- a. When initial maintenance period has not elapsed before end of planting season, or if turf is not fully established, continue maintenance during next planting season.

END OF SECTION 32 9200

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SECTION 32 9300
PLANTS

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. Plants.
- 2. Tree stabilization.

- B. Related Requirements:

- 1. Section 329200 "Turf and Grasses" for turf (lawn) and meadow planting, hydroseeding, and erosion-control materials.

1.3 DEFINITIONS

- A. Backfill: The earth used to replace or the act of replacing earth in an excavation.
- B. Balled and Burlapped Stock: Plants dug with firm, natural balls of earth in which they were grown, with a ball size not less than sizes indicated; wrapped with burlap, tied, rigidly supported, and drum laced with twine with the root flare visible at the surface of the ball as recommended by ANSI Z60.1.
- C. Container-Grown Stock: Healthy, vigorous, well-rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of plant required.
- D. Finish Grade: Elevation of finished surface of planting soil.
- E. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant. Some sources classify herbicides separately from pesticides.
- F. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
- G. Planting Area: Areas to be planted.

- H. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See Section 329113 "Soil Preparation" for drawing designations for planting soils.
- I. Plant; Plants; Plant Material: These terms refer to vegetation in general, including trees, shrubs, vines, ground covers, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.
- J. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.
- K. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees below the soil surface.
- L. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

1.4 COORDINATION

- A. Plant trees, shrubs, and other plants after finish grades are established and before planting seeded lawn areas unless otherwise indicated.
 - 1. When planting trees, shrubs, and other plants after planting seeded lawn areas, protect seeded lawn areas, and promptly repair damage caused by planting operations.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Plant Materials: Include quantities, sizes, quality, and sources for plant materials.
 - 2. Plant Photographs: Include color photographs in digital format of each required species and size of plant material as it will be furnished to Project. Take photographs from an angle depicting true size and condition of the typical plant to be furnished. Include a scale rod or other measuring device in each photograph. For species where more than 200 plants are required, include a minimum of three photographs showing the average plant, the best quality plant, and the worst quality plant to be furnished. Identify each photograph with the full scientific name of the plant, plant size, and name of the growing nursery.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For landscape Installer. Include list of similar projects completed by Installer demonstrating Installer's capabilities and experience. Include project names, addresses, and year completed, and include names and addresses of owners' contact persons.
- B. Product Certificates: For each type of manufactured product, from manufacturer, and complying with the following:
 - 1. Manufacturer's certified analysis of standard products.

2. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.
- C. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.
- D. Sample Warranty: For special warranty.

1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of plants during a calendar year. Submit before expiration of required maintenance periods.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful establishment of plants.
 1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
 2. Experience: Three years of experience in landscape installation.
 3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
 4. Personnel Certifications: Installer's field supervisor and one personnel assigned to the Work shall have certification in one of the following categories from the Professional Landcare Network:
 - a. Landscape Industry Certified Technician - Exterior.
 - b. Landscape Industry Certified Interior.
 - c. Landscape Industry Certified Horticultural Technician.
 5. Pesticide Applicator: State licensed, commercial.
- B. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.
 1. Selection of plants purchased under allowances is made by Architect, who tags plants at their place of growth before they are prepared for transplanting.
- C. Measurements: Measure according to ANSI Z60.1. Do not prune to obtain required sizes.
 1. Trees and Shrubs: Measure with branches and trunks or canes in their normal position. Take height measurements from or near the top of the root flare for field-grown stock and container-grown stock. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip to tip. Take caliper measurements 6 inches above the root flare for trees up to 4-inch caliper size.
 2. Other Plants: Measure with stems, petioles, and foliage in their normal position.

- D. Plant Material Observation: Architect may observe plant material either at place of growth or at site before planting for compliance with requirements for genus, species, variety, cultivar, size, and quality. Architect may also observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and may reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.

1. Notify Architect of sources of planting materials 30 days in advance of delivery to site.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws if applicable.
- B. Bulk Materials:
1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
 3. Accompany each delivery of bulk materials with appropriate certificates.
- C. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.
- D. Handle planting stock by root ball.
- E. Apply antidesiccant to trees and shrubs using power spray to provide an adequate film over trunks (before wrapping), branches, stems, twigs, and foliage to protect during digging, handling, and transportation.
1. If deciduous trees or shrubs are moved in full leaf, spray with antidesiccant at nursery before moving and again two weeks after planting.
- F. Wrap trees and shrubs with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during digging, handling, and transportation.
- G. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.
1. Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.
 2. Do not remove container-grown stock from containers before time of planting.

3. Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary to maintain root systems in a moist, but not overly wet condition.

1.10 FIELD CONDITIONS

- A. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.
- B. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.
 1. Spring Planting: After April 15th.
 2. Fall Planting: Before September 30th.
- C. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements.

1.11 WARRANTY

- A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.
 1. Failures include, but are not limited to, the following:
 - a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner.
 - b. Structural failures including plantings falling or blowing over.
 - c. Faulty performance of tree stabilization.
 - d. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 2. Warranty Periods: From date of Planting Completion.
 - a. Trees: 12 months.
 - b. Ground Covers: 12 Months
 3. Include the following remedial actions as a minimum:
 - a. Immediately remove dead plants and replace unless required to plant in the succeeding planting season.
 - b. Replace plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.
 - c. A limit of one replacement of each plant is required except for losses or replacements due to failure to comply with requirements.

- d. Provide extended warranty for period equal to original warranty period, for replaced plant material.

PART 2 - PRODUCTS

2.1 PLANT MATERIAL

- A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant List, Plant Schedule, or Plant Legend indicated on Drawings and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.
 1. Trees with damaged, crooked, or multiple leaders; tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark"); crossing trunks; cut-off limbs more than 3/4 inch in diameter; or with stem girdling roots are unacceptable.
 2. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.
- B. Provide plants of sizes, grades, and ball or container sizes complying with ANSI Z60.1 for types and form of plants required. Plants of a larger size may be used if acceptable to Architect, with a proportionate increase in size of roots or balls.
- C. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which begins at root flare according to ANSI Z60.1. Root flare shall be visible before planting.
- D. Labeling: Label at least one plant of each variety, size, and caliper with a securely attached, waterproof tag bearing legible designation of common name and full scientific name, including genus and species. Include nomenclature for hybrid, variety, or cultivar, if applicable for the plant.

2.2 FERTILIZERS

- A. Planting Tablets: Tightly compressed chip-type, long-lasting, slow-release, commercial-grade planting fertilizer in tablet form. Tablets shall break down with soil bacteria, converting nutrients into a form that can be absorbed by plant roots.
 1. Size: 10-gram tablets for tree plantings.
 2. Nutrient Composition: 20 percent nitrogen, 10 percent phosphorous, and 5 percent potassium, by weight plus micronutrients.

2.3 MULCHES

- A. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of one of the following:

1. Type: Shredded Fir or Hemlock Mulch
 2. Size Range: 3 inches maximum, 1/2 inch minimum.
 3. Color: Natural.
- B. Compost Mulch: Well-composted, stable, and weed-free organic matter, pH of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through a 1-inch sieve; soluble-salt content of 2 to 5 dS/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
1. Organic Matter Content: 30-40 percent of dry weight.
 2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.

2.4 PESTICIDES

- A. General: Pesticide registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.
- B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
- C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

2.5 TREE-STABILIZATION MATERIALS

- A. Trunk-Stabilization Materials:
1. Upright and Guy Stakes: Rough-sawn, sound, fir or hemlock, free of knots, holes, cross grain, and other defects, 2-by-2-inch nominal by length indicated, pointed at one end.
 2. Plastic Chain-Lock Tree tie: Minimum 1/2" plastic chain lock style tree tie.
 - 3.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive plants, with Installer present, for compliance with requirements and conditions affecting installation and performance of the Work.
1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.

2. Verify that plants and vehicles loaded with plants can travel to planting locations with adequate overhead clearance.
 3. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
 4. Uniformly moisten excessively dry soil that is not workable or which is dusty.
- B. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.
- B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.
- C. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Architect's acceptance of layout before excavating or planting. Make minor adjustments as required.
- D. Lay out plants at locations directed by Architect. Stake locations of individual trees and shrubs and outline areas for multiple plantings.

3.3 PLANTING AREA ESTABLISHMENT

- A. General: Prepare planting area for soil placement and mix planting soil according to Section 329113 "Soil Preparation."
- B. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.4 EXCAVATION FOR TREES AND SHRUBS

- A. Planting Pits and Trenches: Excavate circular planting pits.
1. Excavate planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are unacceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.
 2. Excavate approximately three times as wide as ball diameter for tree stock
 3. Excavate at least double the width of rootball spread and deep enough to accommodate rootball delth.

4. Do not excavate deeper than depth of the root ball, measured from the root flare to the bottom of the root ball.
 5. If area under the plant was initially dug too deep, add soil to raise it to the correct level and thoroughly tamp the added soil to prevent settling.
 6. Maintain angles of repose of adjacent materials to ensure stability. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.
 7. Maintain supervision of excavations during working hours.
 8. Keep excavations covered or otherwise protected when unattended by Installer's personnel
- B. Backfill Soil: Subsoil and topsoil removed from excavations may be used as backfill soil unless otherwise indicated in the soils lab analysis recommendations.
- C. Obstructions: Notify Architect if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.
1. Hardpan Layer: Drill 6-inch diameter holes, 24 inches apart, into free-draining strata or to a depth of 10 feet whichever is less, and backfill with free-draining material.
- D. Drainage: Notify Architect if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits.
- E. Fill excavations with water and allow to percolate away before positioning trees and shrubs.

3.5 TREE, SHRUB, AND VINE PLANTING

- A. Inspection: At time of planting, verify that root flare is visible at top of root ball according to ANSI Z60.1. If root flare is not visible, remove soil in a level manner from the root ball to where the top-most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements.
- B. Roots: Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.
- C. Balled and Burlapped Stock: Set each plant plumb and in center of planting pit or trench with root flare 1 inch above adjacent finish grades.
1. Backfill: Planting soil.
 2. After placing some backfill around root ball to stabilize plant, carefully cut and remove burlap, rope, and wire baskets from tops of root balls and from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
 3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
 4. Place planting tablets equally distributed around each planting pit when pit is approximately one-half filled. Place tablets beside the root ball about 1 inch from root tips; do not place tablets in bottom of the hole.

- a. Quantity: Four per tree.
- 5. Continue backfilling process. Water again after placing and tamping final layer of soil.

3.6 TREE STABILIZATION

- A. Trunk Stabilization by Upright Staking and Tying: Install trunk stabilization as follows unless otherwise indicated:
 - 1. Upright Staking and Tying: Stake trees of 2 inch caliper or 6 foot height balled and burlapped stock. Use a minimum of two stakes for 2" caliper stock and three stakes for 6' height trees of length required to penetrate at least 18 inches below bottom of backfilled excavation and to extend to the dimension indicated on Drawings above grade. Set vertical stakes and space to avoid penetrating root balls or root masses.
 - 2. Support trees with bands of flexible ties at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.
 - 3. Support trees with two strands of plastic tie wire. Allow enough slack to avoid rigid restraint of tree.

3.7 PLANTING AREA MULCHING

- A. Mulch tree planter pit as indicated.
 - 1. Apply wood mulch ring of 3 inch average thickness. Do not place mulch within 3 inches of trunks or stems.

3.8 PLANT MAINTENANCE

- A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing tree-stabilization devices, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings.
- B. Fill in, as necessary, soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.
- C. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use integrated pest management practices when possible to minimize use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.

3.9 PESTICIDE APPLICATION

- A. Apply pesticides and other chemical products and biological control agents according to authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

- B. Pre-Emergent Herbicides (Selective and Nonselective): Apply to tree, shrub, and ground-cover areas according to manufacturer's written recommendations. Do not apply to seeded areas.
- C. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

3.10 REPAIR AND REPLACEMENT

- A. General: Repair or replace existing or new trees and other plants that are damaged by construction operations, in a manner approved by Architect.
 - 1. Submit details of proposed pruning and repairs.
 - 2. Perform repairs of damaged trunks, branches, and roots within 24 hours, if approved.
 - 3. Replace trees and other plants that cannot be repaired and restored to full-growth status, as determined by Architect.
- B. Remove and replace trees that are more than 25 percent dead or in an unhealthy condition before the end of the corrections period or are damaged during construction operations that Architect determines are incapable of restoring to normal growth pattern.
 - 1. Provide new trees of same size as those being replaced for each tree type.
 - 2. Species of Replacement Trees: Same species being replaced.

3.11 CLEANING AND PROTECTION

- A. During planting, keep adjacent paving and construction clean and work area in an orderly condition. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- B. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.
- C. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.
- D. After installation and before Substantial Completion remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.
- E. At time of Substantial Completion, verify that tree-watering devices are in good working order and leave them in place. Replace improperly functioning devices.

3.12 MAINTENANCE SERVICE

- A. Maintenance Service for Trees and Shrubs: Provide maintenance by skilled employees of landscape Installer. Maintain as required in "Plant Maintenance" Article. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established, but for not less than maintenance period below:

1. Maintenance Period: **12** months from date of Substantial Completion.

END OF SECTION 32 9300

SECTION 33 1116
SITE WATER UTILITY DISTRIBUTION PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Pipe and fittings for site water lines including domestic water lines and fire water lines.

1.02 RELATED REQUIREMENTS

- A. Section 31 0000 - Earthwork: Trenching and filling
- B. Section 03 3000 - Cast-in-Place Concrete: Concrete for thrust restraints.

1.03 REFERENCES

- A. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2014.
- B. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120; 2015.
- C. AWWA C500 - Metal-Seated Gate Valves for Water Supply Service; 2009.
- D. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe, 4 In. Through 12 In. (100 mm Through 300 mm), for Water Transmission and Distribution; 2007.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on pipe materials, pipe fittings, valves and accessories.
- C. Project Record Documents: Record actual locations of piping mains, valves, connections, thrust restraints, and invert elevations. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.05 QUALITY ASSURANCE

- A. Perform Work in accordance with utility company requirements.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store valves in shipping containers with labeling in place.

PART 2 PRODUCTS

2.01 WATER PIPE

- A. Copper Tubing: ASTM B88, Type K, annealed:
- B. PVC Pipe: ASTM D1785, Schedule 40.
- C. PVC Pipe: AWWA C900 Class 100:
- D. Trace Wire: Magnetic detectable conductor, clear plastic covering, imprinted with " Water Service" in large letters.

2.02 VALVES

- A. Gate Valves Up To 3 Inches:
 - 1. Brass or Bronze body, non-rising stem, inside screw, single wedge or disc, compression ends, with control rod, post indicator, valve key, and extension box.
- B. Gate Valves 3 Inches and Over:
 - 1. AWWA C500, iron body, bronze trim, non-rising stem with square nut, single wedge, flanged ends, control rod, post indicator, valve key, and extension box.

2.03 ACCESSORIES

- A. Meter Box, Cover and Lid: No. 3 concrete box and lid per authority having jurisdiction.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that building service connection and municipal utility water main size, location, and invert are as indicated.

3.02 PREPARATION

- A. Cut pipe ends square, ream pipe and tube ends to full pipe diameter, remove burrs.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare pipe connections to equipment with flanges or unions.

3.03 TRENCHING

- A. Refer to Section 31 0000 - Earthwork for trenching and back fill
- B. Hand trim excavation for accurate placement of pipe to elevations indicated.
- C. Backfill around sides and to top of pipe with cover fill, tamp in place and compact, then complete backfilling.

3.04 INSTALLATION - PIPE

- A. Group piping with other site piping work whenever practical.
- B. Establish elevations of buried piping to ensure not less than 3 ft of cover.
- C. Route pipe in straight line.
- D. Install pipe to allow for expansion and contraction without stressing pipe or joints.
- E. Install access fittings to permit disinfection of water system performed under Section 33 1300.
- F. Slope water pipe and position drains at low points.
- G. Install trace wire 6 inches above top of pipe.

3.05 INSTALLATION - VALVES

- A. Set valves on solid bearing.
- B. Center and plumb valve box over valve. Set box cover flush with finished grade.

3.06 FIELD QUALITY CONTROL

- A. Perform field inspection and testing in accordance with Section 01 4000.
- B. Pressure test water piping to 100 psi for 1 hour
- C. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to Owner.

END OF SECTION

SECTION 33 1300
DISINFECTING OF WATER UTILITY DISTRIBUTION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Disinfection of site domestic water lines specified in Section 33 1000.

1.02 RELATED REQUIREMENTS

- A. Section 33 1116 Site Water Utility Distribution Piping

1.03 REFERENCE STANDARDS

- A. AWWA B300 - Hypochlorites; 2011.
- B. AWWA B301 - Liquid Chlorine; 2010.
- C. AWWA B302 - Ammonium Sulfate; 2010.
- D. AWWA B303 - Sodium Chlorite; 2010.
- E. AWWA C651 - Disinfecting Water Mains; 2005.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Test Reports: Indicate results comparative to specified requirements.
- C. Certificate: From authority having jurisdiction indicating approval of water system.
- D. Disinfection report:
 - 1. Type and form of disinfectant used.
 - 2. Date and time of disinfectant injection start and time of completion.
 - 3. Test locations.
 - 4. Initial and 24 hour disinfectant residuals (quantity in treated water) in ppm for each outlet tested.
 - 5. Date and time of flushing start and completion.
 - 6. Disinfectant residual after flushing in ppm for each outlet tested.
- E. Bacteriological report:
 - 1. Date issued, project name, and testing laboratory name, address, and telephone number.
 - 2. Time and date of water sample collection.
 - 3. Name of person collecting samples.
 - 4. Test locations.
 - 5. Initial and 24 hour disinfectant residuals in ppm for each outlet tested.
 - 6. Coliform bacteria test results for each outlet tested.
 - 7. Certification that water conforms, or fails to conform, to bacterial standards of Authority Having Jurisdiction.

1.05 QUALITY ASSURANCE

- A. Water Treatment Firm: Company specializing in disinfecting potable water systems specified in this Section with minimum three years documented experience.
- B. Testing Firm: Company specializing in testing potable water systems, certified by governing authorities of the State in which the Project is located.
- C. Submit bacteriologist's signature and authority associated with testing.

PART 2 PRODUCTS

2.01 DISINFECTION CHEMICALS

- A. Chemicals: AWWA B300, Hypochlorite, AWWA B301, Liquid Chlorine, AWWA B302, Ammonium Sulfate, and AWWA B303, Sodium Chlorite or as otherwise required by the authority Having Jurisdiction.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that piping system has been cleaned, inspected, and pressure tested.
- B. Schedule disinfecting activity to coordinate with start-up, testing, adjusting and balancing, demonstration procedures, including related systems.

3.02 DISINFECTION

- A. Use method prescribed by the applicable state or local codes, or health authority or water purveyor having jurisdiction, or in the absence of any of these follow AWWA C651.
- B. Provide and attach equipment required to perform the work.
- C. Inject treatment disinfectant into piping system.
- D. Maintain disinfectant in system for 24 hours.
- E. Flush, circulate, and clean until required cleanliness is achieved; use municipal domestic water.
- F. Replace permanent system devices removed for disinfection.

3.03 FIELD QUALITY CONTROL

- A. Perform field inspection and testing in accordance with Section 01 4000.
- B. Test samples in accordance with AWWA C651.

END OF SECTION

SECTION 33 4111
SITE STORM DRAINAGE UTILITY PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Storm drainage piping, fittings, and accessories.
- B. Connection of drainage system to municipal sewers.

1.02 RELATED REQUIREMENTS

- A. Section 31 0000 - Excavation: Trenching and filling.

1.03 REFERENCE STANDARDS

- A. ASTM C76 - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe; 2015.
- B. ASTM C76M - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe (Metric); 2014.
- C. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets; 2012.
- D. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications; 2014.
- E. ASTM D2680 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Composite Sewer Piping; 2001 (Reapproved 2014).
- F. ASTM D2751 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings ; 2005.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data indicating pipe, pipe accessories.
- C. Project Record Documents:
 - 1. Record location of pipe runs, connections, catch basins, cleanouts, and invert elevations.

1.05 REGULATORY REQUIREMENTS

- A. Conform to applicable code for materials and installation of the Work of this section.

1.06 PROJECT CONDITIONS

- A. Coordinate the Work with termination of storm sewer connection outside building, trenching, connection to municipal sewer utility service.

PART 2 PRODUCTS

2.01 SEWER PIPE MATERIALS

- A. Concrete Pipe: Reinforced, ASTM C 76 (ASTM C 76M), Class II with Wall type A; mesh reinforcement; bell and spigot end joints.
- B. Reinforced Concrete Pipe Joint Device: ASTM C 443 (ASTM C 443M), flexible plastic (bitumen) gasket joint. Gaskets shall comply with AASHTO M-198 751, Type B, and shall be installed in strict accordance with manufacturer's instructions.
- C. Plastic Pipe: ASTM D2680, Acrylonitrile-Butadiene-Styrene (ABS) material; inside nominal diameter as indicated in inches on the drawings; bell and spigot style solvent sealed joint end.

2.02 PIPE ACCESSORIES

- A. Fittings: Same material as pipe molded or formed to suit pipe size and end design, in required tee, bends, elbows, cleanouts, reducers, traps and other configurations required.
- B. Trace Wire: Magnetic detectable conductor, clear plastic covering, imprinted with " Storm Sewer Service " in large letters.

2.03 BEDDING AND COVER MATERIALS

- A. Bedding: $\frac{3}{4}$ "-0" crushed rock with minimum 4" below bottom of pipe. All bedding lifts to be maximum 6" and should be compacted to at least 92% of maximum dry density as determined by the modified proctor test method (ASTM D 1557).
- B. Cover: $\frac{3}{4}$ "-0" crushed rock with. All cover lifts to be maximum 6" and should be compacted to at least 92% of maximum dry density as determined by the modified proctor test method (ASTM D 1557) and 95% maximum dry density in the upper 1 foot of trench.

PART 3 EXECUTION

3.01 TRENCHING

- A. Refer to Section 31 0000 - Earthwork for trenching and backfill requirements.
- B. Hand trim excavation for accurate placement of pipe to elevations indicated.
- C. Backfill around sides and to top of pipe with cover fill, tamp in place and compact, then complete backfilling.

3.02 INSTALLATION - PIPE

- A. Verify that trench cut is ready to receive work and excavations, dimensions, and elevations are as indicated on layout drawings.
- B. Install pipe, fittings, and accessories in accordance with manufacturer's instructions. Seal watertight.
 - 1. Plastic Pipe: Also comply with ASTM D2321.
- C. Lay pipe to slope gradients noted on layout drawings; with maximum variation from true slope of 1/8 inch in 10 feet.
- D. Connect to building storm drainage system, foundation drainage system, and utility/municipal sewer system.
- E. Install continuous trace wire 6 inches above top of pipe.

3.03 INSTALLATION - CATCH BASINS, TRENCH DRAINS AND CLEANOUTS

- A. Form bottom of excavation clean and smooth to correct elevation.
- B. Form and place cast-in-place concrete base pad, with provision for sanitary sewer pipe end sections.
- C. Establish elevations and pipe inverts for inlets and outlets as indicated.
- D. Mount lid and frame level in grout, secured to top cone section to elevation indicated.

3.04 PROTECTION

- A. Protect pipe and bedding cover from damage or displacement until backfilling operation is in progress.

END OF SECTION