HUTTEBALL +OREMUS architecture

INGLEMOOR HIGH SCHOOL
CONCERT HALL + MUSIC BUILDING

Northshore School District No. 417

PROJECT MANUAL – VOLUME 3 of 3

April 13, 2020

PROJECT MANUAL

For

Inglemoor High School
Concert Hall + Music Building

Northshore School District
3330 Monte Villa Parkway
Bothell, WA 98021

DATE: April 13, 2020

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PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Description: The following sections apply to the Work in this Division with the exception of items specifically described in Division 21:

1. Section 230500 General Provisions
2. Section 230505 Project Closeout and System Start-Up
3. Section 230510 Basic Materials and Methods
4. Section 230513 Electrical Provisions for Mechanical Work
5. Section 230520 Mechanical Demolition
6. Section 230548 Vibration Isolation
7. Section 230550 Seismic Control
8. Section 230800 Mechanical Systems Commissioning
9. Section 230810 HVAC Systems Training
10. Section 230820 Systems Operations and Maintenance Manuals

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

Not used.

END OF SECTION 210000

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Description: The Work includes design and construction of complete automatic we and dry fire suppression system.

B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to the Work in this section.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.

B. Codes and Standards:

1. International Fire Code (IFC).
2. ASCE 7, Minimum Design Loads for Buildings and Other Structures.
3. ASME B16.3, Malleable Iron Threaded Fittings.
4. ASSE 1015, Performance Requirements for Double Check Backflow Prevention Assemblies and Fire Protection Backflow Prevention Assemblies.
5. ASTM A 47, Standard Specification for Ferric Malleable Iron Castings.
6. ASTM A 53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
7. ASTM A 135, Standard Specification for Electric-Resistance-Welded Steel Pipe.
8. ASTM A 183, Standard Specification for Carbon Steel Track Bolts and Nuts.
9. ASTM A 197, Standard Specification for Cupola Malleable Iron.
10. ASTM A 449, Standard Specification for Hex Cap Screws, Bolts and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use.
11. ASTM A 536, Standard Specification for Ductile Iron Castings.
12. ASTM A 795, Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use.
13. NFPA 13, Standard for the Installation of Sprinkler Systems.
14. NFPA 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances.
15. NFPA 25, Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.
16. NFPA 70, National Electrical Code.
17. NFPA 72, National Fire Alarm Code.
18. NFPA, Automatic Sprinkler System Handbook.
19. UL 268, Standard for Smoke Detectors for Fire Alarm Signaling Systems.
20. UL 864, Control Units and Accessories for Fire Alarm Systems.
21. UL 1481, Power Supplies for Fire-Protective Signaling Systems.
22. UL 1887, Fire Test of Plastic Sprinkler Pipe for Visible Flame and Smoke Characteristics.
23. Underwriters Laboratories Fire Protection Equipment Directory.

24. Factory Mutual Approval Guide. FM Global Data Sheets 2-8, Earthquake Protection for Water-Based Fire Protection Systems and 3-26, Fire Protection Water Demand for Non-Storage Sprinklered Properties.

C. Fire Sprinkler System Subcontractor's Qualifications for Preparation of Shop Drawings, Installations, Inspections, Maintenance, and Servicing (WAC 212-80-043):

1. Only licensed fire protection sprinkler system contractors shall execute contracts for installation, inspection, maintenance, or servicing of fire protection sprinkler systems or any part of such system.
2. Only licensed contractors who have achieved at least State of Washington Level U licensure shall install, inspect, maintain, and/or servicing the underground portions of fire protection sprinkler systems in the State of Washington.
3. Only licensed fire protection sprinkler contractors who have achieved at least State Level III licensure shall execute contracts for installation, inspection, testing, maintenance and/or servicing of NFPA 13 and other systems per definition of fire protection sprinkler system or any part of such a system in State of Washington.
4. Only those certificates of competency holders who have achieved State Level U certification shall supervise and/or certify installation of underground supplies to fire protection sprinkler systems.
5. Only those certificate of competency holders who have achieved at least State Level III certification shall supervise and/or certify the preparation of layout drawings (Shop Drawings) installation, inspection, testing, maintenance, servicing of, or installation of NFPA 13, and other systems per definition of fire protection sprinkler system in Chapter 18.160 RCW or any part thereof.

D. Grooved Joint Pipe Requirements: Grooved couplings, fittings, valves, and specialties shall be products of one manufacturer including grooving tools. Castings used for coupling housings, fitting, valve bodies, and similar items shall be date stamped.

E. Fire Sprinkler System Contractor's Qualifications: Active NICET Level III (Certified Engineering Technician) Certification in Fire Protection Engineering Technology/Automatic Sprinkler System Layout.

1.3 SYSTEM DESIGN CRITERIA

A. Design, furnish, and install complete operable fire suppression systems in accordance with the latest adopted editions of IBC, IFC, NFPA 13, NFPA 24, NFPA 72, and applicable city, county, and state laws, codes, and standards. Include valves, flow switches, valve monitor switches, low air pressure switches, and accessories to meet requirements of the AHJs and aforementioned codes and standards.

B. In areas where local codes require coverage by either fire sprinklers or heat detectors, provide coverage by fire sprinklers.

C. Coverage: It is the requirement of this section for complete fire sprinkler coverage of the entire facility including:

1. Accessible chases and shafts.
2. Void spaces both combustible and non-combustible.
3. Combustible ceiling spaces **and** Ceiling spaces.

4. Attic spaces.
5. Mechanical rooms.
6. Electrical and telephone rooms.
7. Elevator equipment room.
8. Elevator shaft.

D. The Contractor and the fire suppression system subcontractor shall meet with the AHJs prior to preparation of Shop Drawings and hydraulic and earthquake bracing calculations to review procedures for handling submittals, inspection, testing, and for general coordination and to verify sprinkler occupancy hazard classifications.

E. Obtain latest water supply engineering test data prior to design. Include 10 percent safety margin in system design. If test data is not available, conduct test to determine available flow and pressures to hydraulically design system.

F. Coordination With Other Trades:

1. Coordinate fire suppression work with that of mechanical, sheet metal, plumbing, and electrical subcontractors so that best arrangement of equipment, piping, conduit, ducts, and similar items can be obtained.
2. Identify points of conflict between this work and that of other trades so that conflict may be properly adjusted. Fire suppression system subcontractor shall remove and re-install work which interferes with work of other trades at no additional cost to the Owner.

G. No change orders will be issued for additions and deletions of sprinkler heads and associated piping except as such additions and deletions stem from changes in building design made subsequent to approval of the Shop Drawings.

1.4 SUBMITTALS

A. Comply with requirements in Division 01 and Section 230500.

B. Product Data: Submit manufacturer’s technical product data and maintenance data for the following:

1. Pipe and fittings.
2. Valves.
3. Sprinkler heads.
4. Backflow preventers.
5. Alarm and signal devices.
6. Building fire alarm system interface.
7. Piping specialties.

C. Shop Drawings and Calculations:

1. Comply with requirements in NFPA 13.
2. Comply with requirements in Section 230500
3. Submit preliminary layout showing only head locations for review by the A/E. Include additional heads which may be required for coordinated ceiling pattern at no additional cost to the Owner, even though number of heads may exceed minimum code requirements. Indicate sprinkler head locations as follows:

a. Suspended Accessible Ceilings: Locate heads in center of ceiling tiles up to 2 foot tile dimension, and 1/4 section intervals for 4 foot tile dimension.
b. Suspended Inaccessible Ceilings: Locate heads in conjunction with light fixtures and other devices installed in ceiling in a symmetrical pattern.
c. Arrange heads in straight lines that are parallel and perpendicular to walls.

4. After the A/E review of sprinkler head locations, submit the Shop Drawings and hydraulic and earthquake bracing calculations to the A/E of entire sprinkler system. Shop Drawings shall be complete floor plans showing new work, locations and types of heads, pipe sizes and cutting lengths, locations and sizes of required beam penetrations, locations and types of hangers, test valve(s), drain valves, and other related items. Indicate exposed work.
5. Include risers, flow switches, inside shut-off valves, valve monitor switches, post indicator valves, backflow preventers, vaults, and similar components. Coordinate with work shown on civil drawings but refer to requirements of WAC 212-80-043 for installation of underground portions of fire protection sprinkler systems.
6. Indicate location of alarm and supervisory initiating devices and other devices and electrical equipment associated with the fire suppression systems.
7. Following review and approval by the A/E, submit Shop Drawings and hydraulic and earthquake bracing calculations to the AHJs. Do not proceed with installation until the Shop Drawings have been approved by the AHJs.

D. Certificates Required: Submit copy of certificate from the fire code official.

E. Contractor's Material and Test Certificate: Submit to certify material selection and testing results using form in NFPA 13. Complete applicable portions of form and sign and date it.

F. Contractor's Material and Test Certificate for Aboveground Piping: Submit to certify material selection and testing results using form in NFPA 14. Complete applicable portions of form and sign and date it**.**

G. Obtain from each AHJ written certification that the permanent installation has been inspected and that it complies with the AHJ's published regulations and requirements. Submit prior to Substantial Completion.

H. Test Reports:

1. Field test reports.
2. Submit completed copy of reports and include copy in the Operations and Maintenance Manual.

I. Operations and Maintenance Data:

1. Prepare complete, simple, understandable, step-by-step, testing instructions with recommended and required testing frequency of equipment with methods for testing equipment. Include troubleshooting manual.
2. Prepare complete, easy-to-read, understandable maintenance instructions including the following information:

a. Instruction on replacing components of system including internal parts.
b. List of equipment and components with address and phone number of both manufacturer and local supplier of each item.

3. Include fire suppression system pressure and alarm system tests.
4. Include copies of the following publications:

   a. NFPA 13.
   b. NFPA 25.

5. Submit one week minimum prior to system training.

J. Record Drawings:

1. Provide in accordance with Division 01 and Section 230500.
2. Submit one week minimum prior to system training.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturer of equipment regularly engaged in the manufacture of components specified and with published catalogs listing pertinent specifications of items manufactured. Pipe and fittings shall be manufactured in the United States.

B. Manufacturers name and model identification used throughout this section are to establish general configuration, function, size, performance, and quality.

C. Manufacturers: Victaulic Co., Tyco Fire Protection Products (GRINNELL Products, Central Sprinkler, Gem Sprinkler Company, and Star Sprinkler Inc.), Viking Automatic Sprinkler Company, Reliable Automatic Sprinkler Co. Inc., Globe Fire Sprinkler Corporation, or approved. In general, Victaulic model numbers are listed.

2.2 GENERAL

A. Equipment, Material, and Components Required by NFPA to be Listed: Listed in UL Fire Protection Equipment Directory or approved by FM and the AHJs.

2.3 PIPE AND FITTINGS

A. Pipe:

1. Comply with requirements in NFPA 13.
2. Black steel and galvanized steel, ASTM A 53, ASTM A 135, or ASTM A 795.
3. Pipe, other than Schedule 40 or Schedule 10, acceptable if UL listed and labeled, FM approved, and approved by the AHJs. CPVC pipe not acceptable.
4. Schedule 40 pipe used in cut groove joints and for sizes 2 inch and smaller with screwed joints and fittings.
5. Schedule 10 pipe used for rolled grooved joints. Rolled grooved joints for dry pipe sprinkler systems not acceptable.
6. Internal and external galvanized steel for exterior pipes, dry pipe sprinkler systems, buried pipe if not ductile iron, and drains.

7. Flexible sprinkler connections may be used at the Contractor option. If used, shall be braided type. Install with union joint threaded fittings. Include open-gate ceiling attachment bracket to allow sprinkler connection installation prior to installation of ceiling tile. The drop includes a male threaded nipple or Victaulic FireLock IGS Style 108 captured coupling for connection to branch line piping. UL approved Series AH1 hose with 3" bend radius and AH2 or AHC-CC with 2" bend radius. Pressure fit type fittings not acceptable. Oversized ring, sleeve, or adaptor through ceiling not required. Victaulic® VicFlex™, FlexHead Industries, EASYFLEX, or approved.
8. Include return bends for pendent sprinkler heads.
9. Ductile iron, cement lined, Class 52, mechanical or push-on restrained joints for underground pipe.

B. Fittings:

1. Comply with requirements in NFPA 13.
2. Minimum 125 psi class.
3. 2 Inch and Smaller: 150 pound black malleable or ductile iron, screwed, ASME B16.3 and ASTM A 197. Threadolet type fittings acceptable for Schedule 40 pipe only.
4. 2-1/2 Inch and Larger: Grooved joint fittings, ductile iron ASTM A 536 bodies. Flanged fittings, forged steel, or ductile iron.
5. Grooved Joint Couplings: UL listed and labeled for sprinkler service. 2 ductile iron ASTM A 536 housings. EPDM or chlorinated butyl gasket. Nuts and bolts ASTM A 449 and ASTM A 183. Minimum 110,000 psi tensile.

    a. Rigid Type Couplings: Cast housings with offsetting, angle-pattern, bolt pads, and system support and hanging as required by NFPA 13. Victaulic Co. 009-EZ and Style 107N; installation-ready, for direct stab installation without field disassembly.
    b. Flexible Type Couplings: For seismic applications and in locations where vibration isolation and stress relief are required. Victaulic Co. Installation-Ready Style 177, or Style 75 and Style 77.

6. Installation-Ready™ fittings for Schedule 40 grooved end steel piping in fire protection applications sizes NPS 1-1/4 thru 2-1/2 (DN 32 thru DN 65). Fittings shall consist of a ductile iron housing conforming to ASTM A-536, Grade 65-45-12, with Installation-Ready™ ends, orange enamel coated. Fittings complete with prelubricated Grade "E" EPDM Type 'A' gasket; and ASTM A449 electroplated steel bolts and nuts. System shall be UL listed for a working pressure of 300 psi (2065 kPa) and FM approved for working pressure 365 psi (2517kPa).
7. Victaulic FireLock™ IGS Groove System for Carbon Steel Pipe - In lieu of threaded steel piping systems, the Victaulic FireLock IGS System with "Installation-Ready™ fittings and couplings may be used for NPS 1 (DN 25) Schedule 10 and Schedule 40 carbon steel pipe in fire protection applications. System rated for a working pressure to 365 psi (2517 kPa).

    a. Groove: IGS "Innovative Groove System" groove with shortened "A" dimension and tapered groove backside for ease of installation.
    b. Grooving Tool: Victaulic RG2100, with IGS Confirmation Gauge.
    c. Fittings: Ductile iron housing conforming to ASTM A-536, Grade 65-45-12. Orange enamel coated or galvanized. Victaulic Style 101 (90-degree elbow), Style 102 (tee), and Style 108 (coupling) with Installation-Ready™ ends..
    d. Coupling: Style 108 single-bolt coupling provided with EPDM Type A pressure responsive gasket with Vic-Plus lubricant, and ASTM A449 compliant electroplated steel bolt and nut. CrMo alloy steel coupling linkage.

8. Internal and external galvanized steel fittings for exterior pipes, dry pipe sprinkler systems, and drains.
9. Plain End Couplings: Plain end couplings (Roust-A-Bouts, Plainloks or similar couplings) not acceptable.
10. Hole Cut Outlets: Hole cut bolted branch outlet couplings may be used as approved by the AHJs. Hole cut outlets full bodied outlet (U-bolt outlets not acceptable). Victaulic Co. Style 920 and 920N.
11. Ductile iron, cement lined, Class 52, mechanical or push-on restrained joints for underground pipe.

2.4 VALVES

A. General: UL listed and labeled and FM approved, minimum 175 psi class.

B. Gate Valves:

1. 2 Inch and Smaller: Bronze body, solid wedge disc, OS&Y, screwed, rising stem. Include valve monitor switch.
2. 2-1/2 Inch and Larger: Cast or ductile iron body, solid wedge disc, OS&Y, grooved ends or flanged, rising stem. Include valve monitor switch. Victaulic Co. Series 771H.

C. Butterfly Valves: Cast or ductile iron body with internal surfaces coated and disc coated or plated. Pressure responsive elastomer seat, and the stem offset from the disc centerline to provide complete 360-degree circumferential seating. Include weatherproof actuator with slow close handwheel and gear operator and visual indication of valve position. End connections wafer, lug, or grooved. Include built-in dual valve monitor switch. Victaulic Co. Style 705.

D. Check Valves: Spring-assisted swing check, end connections to match adjacent piping, cast iron or ductile body, bronze seat, stainless steel or elastomeric-coated clapper, stainless steel spring and shaft with replaceable rubber seal. Suitable for vertical or horizontal installation. Include tapping for bronze ball drip drain for fire department connection. Victaulic Co. Series 717.

E. Wet Pipe Sprinkler System Alarm Valve and Appurtenances: Cast or ductile iron body, cast aluminum-bronze clapper, clamp ring, and valve seat. Include tapped bosses with standard trim including system alarm and supervisory devices, retarding chamber with auxiliary valve, pressure gages, pressure operated relief valve, alarm test valve, and drain valves. Valve internal components replaceable without removing valve. Victaulic Co. Series 751.

F. Dry Pipe Sprinkler System Alarm Valve and Appurtenances: Cast or ductile iron low differential type alarm valve and trim, riser-mounted air compressor for 13 psig supply pressure for air maintenance device (low air pressure supervisory switch), accelerator (quick opening device), anti-flood device, and system alarm and supervisory devices. Coordinate emergency power for air compressor and fire alarm requirements with work of Division 28. Valve externally resettable and internal components replaceable without removing valve. Victaulic Co. Series 768N or approved equal

G. Detector Check Valve Assembly: UL listed and labeled. As listed in “Backflow Prevention Assemblies Approved for Installation in Washington State”. Include 2 valve monitor switches.

2.5 SPRINKLER HEADS

A. Automatic sprinkler quick response heads of type as required by the AHJs and finish as required for areas and ceiling construction designated. Refer to Article “Sprinkler Heads Schedule” in this section.

B. Operating Temperature: Comply with requirements in NFPA 13 and the AHJ. Select to compensate for the maximum temperatures which occur in particular area during either winter or summer conditions from such sources as unit heaters and sunlight. In no case use heads rated less than 50 F higher than anticipated ambient temperature.

C. Sprinklers shall be glass bulb type, with hex shaped wrench boss integrally cast into the sprinkler body to reduce the risk of damage during installation. (Wrenches provided by the sprinkler manufacturer that directly engage the cast wrench boss.)

D. Extended coverage sprinkler heads may be used subject to approval by the AHJs.

E. Include escutcheon, self-adjusting type, spring-loaded, or friction fit for each pendent sprinkler head fitting against ceiling.

F. Sprinkler Head Guards: Include where sprinkler heads are subject to damage and for sprinkler heads installed lower than 7 feet above finished floor, grating, and in maintenance access areas. Wire basket type with screw type fastener. Spring clip type fastener not acceptable. Chrome or nickel plated in finished areas.

G. Escutcheons and guards shall be listed, and supplied for use with the sprinkler by the sprinkler manufacturer.

H. Sprinkler Cabinet: Include with required number of sprinkler heads of ratings and types installed. Also include escutcheons and sprinkler wrench.

I. Manufacturers: Victaulic, Tyco, Viking or approved equal.

2.6 BACKFLOW PREVENTERS

A. Double Check Valve Assembly: UL listed and labeled. As listed in “Backflow Prevention Assemblies Approved for Installation in Washington State”. Tested and certified under ASSE 1015.

2.7 ALARM AND SIGNAL DEVICES

A. Water Flow Switch (Systems without Alarm Valves): Vane or paddle type flow switch, installed and connected in such a manner that flow of water equal to or greater than that from a single head will automatically energize fire alarm system. Include field adjustable time delay, adjustable from 0 to 60 seconds. System Sensor or approved.

B. Water Flow Switch (Systems with Wet Pipe Alarm Valve, Dry Pipe Alarm Valve, Preaction Alarm Valve, and Deluge Valve): Pressure type. System Sensor or approved.

C. Low Air Pressure Supervisory Switch (Dry Pipe and Preaction Systems): Arrange to detect problem with maintaining air pressure in pipe. System Sensor or approved.

D. Valve Monitor (Tamper) Switches: 120 V. Built-in dual supervisory switch or attachment for field installed external supervisory switch for gate valves. Include for post indicator valves shown on civil drawings. System Sensor or approved.

E. Pressure Gages: 3-1/2 inch dial, phosphor bronze tube, brass socket, 300 psi range. Include needle valve. System Sensor or approved.

F. Water Motor Gong: Weatherproof with aluminum red-enameled painted hood, nylon bearings, and inlet strainer. Designed to provide local audible alarm upon flow of water in sprinkler systems. Victaulic Style 760 or Electric Alarm Bell: 120 V. Weatherproof with red enameled painted hood, back box, and pressure switch. System Sensor or approved.

2.8 BUILDING FIRE ALARM SYSTEM INTERFACE

A. Coordinate with work specified in Division 28.

2.9 PIPING SPECIALTIES

A. Pipe Supports: Include metal pipe supports, flexible connections, sway braces, hangers, clamps, and other pipe support items in accordance with requirements in NFPA 13 and the AHJ. Seismically design pipe hangers and braces per IBC, ASCE 7, and NFPA 13. Do not use “C-Clamp” hangers unless they include integral seismic retaining strap.

B. Identification Signs: Enameled signs for drain valves, test valves, control valves, and alarm valves indicating their use.

C. Miscellaneous Connections and Fittings: Drain valves, inspector’s test connections, flushing connections, discharge outlets, sight glasses, and other items in accordance with requirements in NFPA 13.

D. Air Venting: Automatic float type air vent with 40 mesh Y-type strainer and 1/2 inch NPT male connection with drain attachment. Include 1/2 inch ball valve upstream of strainer to allow replacement of air release valve without disabling sprinkler system. UL listed and FM approved. Potter Electric Signal Company, LLC Model PAV or approved.

E. Pipe Sleeves: Comply with requirements in Section 230510.

F. Pipe Escutcheon Plates: Comply with requirements in Section 232116.

G. Access Doors: Comply with requirements in Section 230510 for construction features.

PART 3 - EXECUTION

3.1 INSPECTION

A. General: Verify installation conditions as satisfactory to receive the Work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

3.2 PREPARATION

A. Field Measurements: Field verify locations of new and existing work prior to commencing the Work of this section.

B. Protection: Protect surrounding areas and surfaces to preclude damage from the Work of this section.

3.3 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

A. General: Install, apply, erect, and perform the Work in accordance with Article “Quality Assurance” provisions, specifications, and manufacturer’s installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

B. Cooperate with other trades to ensure adequate space for piping placement.

C. Review Drawings, Specifications, and Shop Drawings of other trades to coordinate work and minimize unnecessary offsets and revisions to approved Shop Drawings. Failure to coordinate does not relieve fire suppression subcontractor from meeting performance standards specified in this section.

1. Fire suppression piping shall not:

    a. Reduce headroom to less than 7’-0”.
    b. Project into any passageway, ladder run, access or egress.
    c. Interfere with electrical equipment or access to mechanical units (including filters).

2. Install pipe and sprinkler heads to avoid conflicts with maintenance personnel’s access to equipment. Do not run fire suppression piping at floor in mechanical rooms and maintenance access areas.
3. Relocate piping and sprinkler heads which, in the opinion of the A/E, do not comply with preceding paragraph in manner acceptable to the A/E. Such relocation may be directed during the Shop Drawing review and during construction. If doubt should exist as to compliance of above, suppression system subcontractor shall review situation with the A/E prior to rough-in.

D. Do not order, fabricate, or install materials until approvals are received from the AHJs.

E. Install material in strict accordance with the Shop Drawings approved by the AHJs and reviewed by the A/E.

F. Service Interruptions: Comply with requirements of Section 230500. Obtain advance approval from the Owner and local fire department.

3.4 EARTHWORK

A. Comply with requirements in Section 230510.

3.5 FIRE SUPPRESSION SYSTEMS INSTALLATION

A. Install underground service entrance piping according to NFPA 24.

B. Install piping concealed above furred ceilings to minimize obstructions. Offset, crossover, and route piping to install system in available space. Install to minimize obstruction to work of other trades. Expose only heads. Only fire suppression piping specifically called out on the Contract Documents as being exposed shall be below ceiling construction. Install piping through holes in beams where noted on the Drawings.

C. Install dry pipe systems to slope to low points, including pipe installed in heated areas.

D. Hang piping from roof structure and not from roof deck itself and not from work of other trades. Hanging pipes from ducts and equipment not acceptable except branch piping serving single sprinkler head below ducts and equipment. For branch piping hung below ducts and equipment, coordinate with those trades for design of duct and equipment hangers and supports to comply with requirements of NFPA 13.

E. Install piping system braced to withstand damage from earthquakes. Install flexible couplings and earthquake bracing in accordance with IBC, ASCE 7, and NFPA 13.

F. Grooved Joints: Install in accordance with the manufacturer's latest published installation instructions. Pipe ends shall be clean and free from indentations, projections and roll marks in the area from pipe end to (and including) groove. Gasket shall be manufactured by the coupling manufacturer and verified as suitable for the intended service. A factory trained representative (direct employee) of the coupling manufacturer shall provide on-site training for contractor's field personnel in the use of grooving tools, application of groove, and product installation. The representative shall periodically visit the job site and review installation to ensure best practices in grooved joint installation are being followed. Contractor shall remove and replace any improperly installed products.

G. Hole Cut Outlets: Use cutting tool to form opening in pipe. After "coupon" has been removed, securely attach it to bottom of pipe as evidence that it has not been left in pipe.

H. Install system and auxiliary drains to discharge to paved areas, concrete splash blocks, suitable waste within building, or to other locations as indicated or required by the A/E. Exterior drain locations shall be approved by the A/E. Install drain outlets on the building exterior between 6 and 18 inch above finished grade. Direct connection to sewer systems not acceptable. Install drain valves at interior walls maximum 5 feet above finished floor or grating. Do not install drain valves on outside of building. For concealed drain valves, install access panels. Install dirt legs and drain valves at low points of piping to permit complete drainage of system without disconnection of any piping.

I. Install ball drip valve on check valve to drain piping for fire department connection. Drain to floor receptor or outside building.

J. Escutcheon Plates: Install at exposed pipe penetrations of ceilings, floors, and walls.

K. Install head guards on sprinkler heads installed lower than 7 feet above finished floor and grating, and in maintenance access areas. Install on exterior sprinkler heads.

L. Install sprinkler cabinet adjacent to alarm valve assembly.

M. Install inspector test valve at highest and most hydraulically remote part of system in relation to riser assembly. Locate test valves to be accessible from floor. Coordinate locations with the A/E. Pipe to standpipe drain.

N. Install sleeves through walls and floors. Comply with requirements in Section 230510.

O. Install backflow preventers in accordance with requirements of “Backflow Prevention Assemblies Approved for Installation in Washington State”. Pipe funnel to nearest drain.

P. Install water motor gong **or** electric alarm bell on exterior wall of building. Obtain A/E approval of location.

Q. Install fire department connection in sitework above grade as indicated on the civil Drawings.

R. Install concrete thrust blocks and restraining rods for ductile iron fittings per NFPA 24 and as detailed on the Drawings.

S. Identification Signs: Install with chain on stem of valves. Comply with requirements in NFPA 13.

T. Install access doors, minimum 20 inch by 30 inch, for access to inaccessible void, ceiling, and attic spaces. Coordinate locations with the A/E and show locations on Shop Drawings.

U. Install flexible sprinkler connections with return bends for dry pipe systems with hard pipe for risers and first elbow.

V. Install air venting at high point for each wet pipe sprinkler system per NFPA 13. Include drain pipe and terminate over floor receptor.

3.6 FIRE DETECTION AND SYSTEM ACTUATION

A. Coordinate with fire alarm system work in Division 28.

B. Switches: Install water flow alarm switch for fire sprinkler systems. Install low air pressure switch for dry pipe alarm valve risers. Install valve monitor (tamper) switches for valves.

3.7 ELECTRIC POWER FOR FIRE SUPPRESSION SYSTEMS

A. Coordinate electrical power source required for work of this section with Division 26.

B. Where not shown on the electrical drawings, provide power wiring from electrical panel circuit breakers to devices requiring line voltage power. Similarly, provide low voltage wiring from alarm and supervisory devices to fire alarm system for final connections by fire alarm system subcontractors. Electrical interface shall be responsibility of fire suppression system contractor.

C. Where emergency power is included in the work or exists in building, extend electrical power source from that emergency power system.

3.8 FIELD QUALITY CONTROL

A. Tests:

1. Flush, test, and inspect fire suppression systems in accordance with NFPA 13 and NFPA 25. No leakage permitted in piping. Prior to performing pressure test, notify the AHJs and the A/E of pressure test schedule.
2. Test complete alarm system, including control and signal circuits:

    a. Operate each signal initiating device.
    b. Test operation of features of system under normal operation.
    c. Test supervisory features of system.

3. Class III Standpipe Pressure Regulating Hose Valves: Measure pressure upstream of hose valve, downstream of hose valve, and total flow.

B. Notice: Give 1 week notice and arrange for field tests and inspections by the AHJs. Include paying for inspection fees and securing permits for same.

C. Approval and Acceptance: After fire suppression systems have been completely installed, tested, and Substantial Completion review items corrected, obtain approval and acceptance of systems by the AHJs in accordance with NFPA 13. Retests due to failure to meet design requirements shall be at no additional cost to the Owner. Submit completed Contractor's Material and Test Certificate using form in NFPA 13.

3.9 CLEANING AND PROTECTION

A. Clean dirt and debris from sprinklers.

B. Apply masking tape or paper cover to protect sprinkler heads, cover plates, and sprinkler escutcheons to protect from field painting. Remove after painting. Remove sprinkler heads having paint other than factory finish and provide new. Cleaning and reuse of painted sprinkler heads not acceptable.

C. Protect sprinkler heads from damage until Substantial Completion.

D. Fire suppression system subcontractor shall be responsible during installation and testing periods of sprinkler systems for any damage to work of others and to building and its contents caused by leaks in equipment, by unplugged or disconnected pipes, and fittings, and by overflow. Pay for necessary replacements or repairs to work of others damaged by such leakage.

3.10 FIRE SUPPRESSION SYSTEMS TRAINING

A. Comply with requirements in Section 230810.

B. Prior to date of Substantial Completion, instruct the Owner and their selected personnel in operation of fire suppression systems. Take special care to ensure that the Owner will:

1. Immediately recognize whether shutoff valves are open or closed position.
2. Coordinate with the Owner to minimize damage that can occur when discharging system water.
3. Know how to drain systems.
4. Know how to test waterflow alarms and valve monitor (tamper) switches.
5. Be familiar with contents of material included in the Operations and Maintenance Manual described in this section.
6. Review with the Owner frequencies of inspections and tests required by NFPA 25.

3.11 COMMISSIONING

A. Equipment and systems referenced in this section shall be commissioned per Section 230800. The Contractor has specific responsibilities for scheduling, coordination, test development, testing and documentation.

3.12 SPRINKLER HEADS SCHEDULE

Area/Ceiling	Head Type	Head Finish	Escutcheon Finish
Suspended or Hard Ceiling	Concealed	Polished Chrome	White and Cover Plate Color as Selected by the A/E
Areas without Suspended or Hard Ceilings	Upright	Satin Chrome	
Where Required	Sidewall	Satin Chrome	White
Subject to Freezing and not Connected to Dry Pipe System	Dry Recessed Pendent or Dry Recessed Sidewall	Polished Chrome	Polished Chrome

END OF SECTION 211000

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Description: The following sections apply to the Work in this Division with exception of items specifically described in Division 22:

1. Section 230500 General Provisions
2. Section 230505 Project Closeout and System Start-Up
3. Section 230510 Basic Materials and Methods
4. Section 230513 Electrical Provisions for Mechanical Work
5. Section 230520 Mechanical Demolition
6. Section 230533 Electrical Heat Trace
7. Section 230548 Vibration Isolation
8. Section 230550 Seismic Control
9. Section 230593 Testing, Adjusting, and Balancing
10. Section 230700 Mechanical Insulation
11. Section 230800 Mechanical Systems Commissioning
12. Section 230810 Systems Training
13. Section 230820 Systems Operations and Maintenance Manuals
14. Section 232116 Piping Specialties
15. Section 235100 Flues and Stacks

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

Not used.

END OF SECTION 220000

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. Commissioning process requirements for Plumbing systems, assemblies, and equipment.

B. Related Sections:

1. Section 019100 "General Commissioning Requirements".
2. Division 22 “Plumbing”.
3. Division 23 “Heating, Ventilating, and Air Conditioning (HVAC)”.
4. Division 26 “Electrical”.

2.1 GENERAL DESCRIPTION

A. Commissioning Authority (CA)

1. The CA has been contracted directly with the owner for this project. The CA has overall responsibility for planning and coordinating the commissioning process. However commissioning involves all parties to the design and construction process, including the plumbing (Division 22) contractor, and all specialty sub-contractor within Division 22, such as sheet major equipment suppliers as required.

B. Contractor Responsibility

1. The plumbing (Division 22) contractor’s responsibilities are defined in Section 01 91 00 of the specifications. These responsibilities apply to all specialty sub-contractors and major equipment suppliers within Division 22. Each contractor and supplier shall review Section 019100, and their bids shall include for carrying out the work described, as it applies to each Section within the Division 22 specifications, individually and collectively.

C. Plumbing equipment and systems to be commissioned

1. Domestic hot water heater equipment and recirculation system

PART 2 - PRODUCTS

A. Refer to Section 019100 “General Commissioning Requirements” for minimum testing instrumentation criteria and performance.

B. Standard certified test equipment for commissioning will be provided by the Commissioning Authority.

C. All proprietary testing equipment and instrumentation required to verify and test system and equipment performance shall be provided by installing contractor and made available to the Commissioning Authority.

PART 3 - EXECUTION

1.1 GENERAL TESTING REQUIREMENTS

A. Contractor shall provide technicians, instrumentation, and tools to perform commissioning tests at the direction of the CA and as outlined in Section 01 91 00 "General Commissioning Requirements".

B. Scope of plumbing testing shall include entire PLUMBING installation, from central equipment through distribution systems. Testing shall include measuring capacities and effectiveness of operational and control functions.

C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system (BAS) controllers and sensors.

D. The CA shall prepare detailed testing plans, procedures, and checklists for PLUMBING systems, subsystems, and equipment.

E. Tests will be performed using design conditions whenever possible.

F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.

G. The CA may direct that set points be altered when simulating conditions is not practical.

2.1 INSTALLATION VERIFICATION AND START-UP ACTIVITIES

A. Refer to General Commissioning Specification Section 019100.

3.1 TEST, ADJUST AND BALANCE VERIFICATION

A. Refer to General Commissioning Specification Section 019100.

B. The CA will notify TAB Contractor in advance of the date of field verification. The water balancing will be de-bugged, completed and approved before the CA completes a TAB validation of water-related equipment or systems. The CA will direct a TAB checkout by verifying the values reported in the final TAB report. Advanced notice will not include data points to be verified.

C. The TAB Contractor shall use the same instruments (by model and serial number) that were used when original data were collected. The contractor shall also provide equipment necessary for checkout including, but not limited to, tools, instruments, ladders, lifts, computers, software, cables, etc.

4.1 POINT TO POINT VERIFICATION AND FUNCTIONAL PERFORMANCE TESTING

A. Refer to General Commissioning Specification Section 019100.

B. Functional performance testing and verification may be achieved by manual testing (persons manipulate the equipment and observe performance) or by monitoring the performance and analyzing the results using the control system's trend log capabilities or by stand-alone dataloggers.

C. Simulated Conditions. Simulating conditions (not by an overwritten value) shall be allowed, though timing the testing to experience actual conditions is encouraged wherever practical.

D. Overwritten Values. Overwriting sensor values to simulate a condition, such as overwriting the outside air temperature reading in a control system to be something other than it really is, shall be allowed, but shall be used with caution and avoided when possible. Such testing methods often can only test a part of a system, as the interactions and responses of other systems will be erroneous or not applicable. Simulating a condition is preferable rather than overwriting the value or by altering the appropriate setpoint to see the desired response. Before simulating conditions or overwriting values, sensors, transducers and devices shall have been calibrated.

E. Altering Setpoints. Rather than overwriting sensor values, and when simulating conditions is difficult, altering setpoints to test a sequence is acceptable.

F. Setup. Each function and test shall be performed under conditions that simulate actual conditions as close as is practically possible. The Sub executing the test shall provide all necessary materials, system modifications, etc. to produce the necessary flows, pressures, temperatures, etc. necessary to execute the test according to the specified conditions. At completion of the test, the Sub shall return all affected building equipment and systems, due to these temporary modifications, to their pre-test condition.

5.1 TRAINING

A. Refer to General Commissioning Specification Section 019100.

6.1 OPERATION AND MAINTENANCE MANUALS

A. Refer to General Commissioning Specification Section 019100.

END OF SECTION 220800

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Description: The Work includes domestic water piping for potable and non-potable systems and associated appurtenances.

B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to the Work in this section.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.

B. Codes and Standards:

1. Applicable plumbing code pertaining to materials, products, and installation of domestic water piping.
2. ASHRAE Standard 188, Legionellosis: Risk Management for Building Water Systems.
3. ASME B1.20, Hose Coupling Screw Threads – Inch.
4. ASME B16.18, Cast Copper Alloy Solder Joint Pressure Fittings.
5. ASME B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
6. ASME B31.1, Power Piping.
7. ASME B31.9, Building Services Piping.
8. ASSE 1001, Performance Requirements for Atmospheric Type Vacuum Breakers.
9. ASSE 1010, Performance Requirements for Water Hammer Arrestors.
10. ASSE 1011, Performance Requirements for Hose Connection Vacuum Breakers.
11. ASSE 1012, Performance Requirements for Backflow Preventers with an Intermediate Atmospheric Vent.
12. ASSE 1013, Performance Requirements for Reduced Pressure Principle Backflow Preventers and Reduced Pressure Principle Fire Protection Backflow Preventers.
13. ASSE 1015, Performance Requirements for Double Check Backflow Prevention Assemblies and Fire Protection Backflow Prevention Assemblies.
14. ASSE 1018, Performance Requirements for Trap Seal Primer Valves – Potable Water Supply.
15. ASSE 1020, Performance Requirements for Pressure Vacuum Breaker Assemblies.
16. ASSE 1022, Performance Requirements for Backflow Preventer for Beverage Dispensing Equipment.
17. ASSE 1044, Performance Requirements for Trap Seal Primer Devices-Drainage Types and Electronic Design Types.
18. ASSE 1056, Performance Requirements for Spill Resistant Vacuum Breaker Assemblies.
19. ASTM A 183, Standard Specification for Carbon Steel Track Bolts and Nuts.
20. ASTM A 536, Standard Specification for Ductile Iron Castings.
21. ASTM A 666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
22. ASTM B 32, Standard Specification for Solder Material.
23. ASTM B 75, Standard Specification for Seamless Copper Tube.

24. ASTM B 88, Standard Specification for Seamless Copper Water Tube.
25. ASTM B 633, Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
26. ASTM B 813, Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube.
27. ASTM B 828, Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings.
28. ASTM F 1545, Standard Specification for Plastic-Lined Ferrous Pipe, Fittings, and Flanges.
29. AWS A5.8, Specification for Brazing Filler Metal.
30. AWWA C 104/A 21.4, Cement Mortar Lining for Ductile Iron Pipe and Fittings for Water.
31. AWWA C 110/A 21.10, Standard for Ductile-Iron and Gray Fittings for Water.
32. AWWA C 111/A 21.11, Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
33. AWWA C 151/A 21.51, Standard for Ductile-Iron Pipe, Centrifugally Cast.
34. AWWA C 153/A21.53, Standard for Ductile-Iron Pipe Compact Fittings for Water Service.
35. AWWA C651, Disinfecting Water Mains.
36. AWWA C652, Disinfection of Water Storage Facilities.
37. AWWA C700, Standard for Cold-Water Meters – Displacement Type, Bronze Case.
38. AWWA C701, Standard for Cold-Water Meters – Turbine Type, for Customer Service.
39. AWWA C702, Standard for Cold-Water Meters – Compound Type.
40. NFPA 13, Standard for the Installation of Sprinkler Systems.
41. NSF 14, Plastic Piping System Components and Related Materials.
42. NSF 61, Drinking Water Systems Components – Health Effects.
43. NSF 372, Drinking Water Systems Components – Lead Content.
44. PDI-WH 201, Water Hammer Arrestors.

C. Installer's Qualifications for Copper Press Fitting Couplings: Installers shall be certified by the pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.

D. Domestic Water Systems: Products carrying and dispensing water for consumption through drinking and cooking shall be certified by an independent, ANSI credited, third party certification organization to requirements of NSF 61 and NSF 372 for 0.25 percent maximum lead content for wetted component base material.

1.3 SUBMITTALS

A. Comply with requirements in Division 01 and Section 230500.

B. Product Data: Submit manufacturer's technical product data and maintenance data for the following:

1. Copper tubing including solder and flux.
2. Dielectric unions.
3. Backflow preventers.
4. Y-type strainers
5. Basket strainers.
6. Water meters.
7. Trap primers.
8. Water hammer arresters.

9. Non-potable water signage
10. Blank copy of start-up and test report form.

C. Shop Drawings:

1. Comply with requirements in Section 230500 regarding 3D Shop Drawings.

D. Installer Qualification Data for Copper Press Fitting Couplings.

E. Certificates:

1. Certificates of Inspection by Authorities Having Jurisdiction (AHJ)
2. Certificates of Satisfactory Bacteriological Test. Include copy in the Operations and Maintenance Manual.
3. Certificates of flushing and sterilization with approval by the AHJ.
4. Certification to NSF 61 and NSF 372 for no-lead/low lead products.
5. Certificates of installers for copper press fittings.

F. Test Reports:

1. Field test reports.

1.4 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION

A. Section 230900 – Automatic Temperature Controls: Thermal wells, flow switches, and similar components.

PART 2 - PRODUCTS

2.1 GENERAL

A. Furnish products of sizes, ratings, and characteristics indicated, which comply with manufacturer's standard materials, design, and construction in accordance with published product information. Furnish quantity of piping and appurtenances required for complete installation.

B. Pressure Ratings: Provide components with minimum pressure rating of 125 psig working pressure.

2.2 MANUFACTURERS

A. Copper Tubing: Cerro, Mueller and Wolverine.

B. Copper Tube Fittings: NIBCO®, Mueller, Elkhart.

C. Gaskets: Crane, Garlock, U. S. Rubber, Anchor, Flexitallic. Rubber, plastic, and silicone gaskets not acceptable for domestic hot water systems.

2.3 COPPER TUBING

A. General: Copper tubing only. Sweat or press fittings joint connections only.

B. Above Ground: Type L copper water tube, hard-drawn, ASTM B 88.

C. Underground: Type K copper water tube, soft-drawn, ASTM B 88.

D. Tubing, Flexible: Soft copper tubing, flexible stainless steel hose, or approved. Rated for design working pressure of application.

E. Fittings: Wrought copper fittings and screwed adapters for soldered and brazed joints, ASME B16.22. Cast bronze fittings and screwed adapters for soldered and brazed joints, ASME B16.18.

F. Copper Press Fitting Couplings and Fittings:

1. Suitable for Types K and L hard drawn copper tubing for sizes 1/2 through 2-1/2 inch and soft drawn copper tubing for sizes 1/2 through 1-1/4 inch. Press-to-connect joint made with pressing tool and jaw sets recommended by fitting manufacturer. NIBCO® Press System™, Viega ProPress System, or Elkhart XPress. No substitutions.
2. Approved by NSF International, IAPMO, UL and compliant with UPC, NFPA 13, and NFPA 99.
3. Wrought copper fittings per ASTM B 75 conforming to ASME B16.18 or ASME B16.22. Rated to maximum 200 psig non-shock working pressure for temperature range between minus 20 F to 250 F.

G. Unions: Wrought copper solder joint unions, ASME B16.22; cast bronze solder joint fittings, ASME B16.18.

H. Flanges and Flanged Fittings: Cast bronze, 125 pound Class, ASME Standards.

I. Gaskets: 1/16 inch thick compressed non-asbestos material selected for applicable temperature and pressure of systems installed. Full face gaskets for flat faced flanges.

J. Joint Compound: Teflon tape.

K. Solder Material: 95 percent tin, 5 percent antimony solder or 96 percent tin 4 percent silver conforming to ASTM B 32 and NSF 61. Lead free (not more than 0.2 percent lead). Flux water soluble conforming to ASTM B 813. J.W. Harris “Bridgit”, Rectorseal, Oatey, Superior Flux, Worthington Cylinders, BerzOmatic, or approved.

L. Brazing Material: Copper-phosphorus alloys, BcuP Series, conforming to AWS A5.8. Lead free (not more than 0.2 percent lead) conforming to ASTM B 32 and NSF 61. Flux water soluble conforming to ASTM B 813. Rectorseal, Oatey, Superior Flux, or approved.

2.4 DIELECTRIC UNIONS

A. Union Style: Grooved, threaded, or plain end, ASTM F 1545. Capital Series CS; Epco Dielectric Unions, PPP Clearflow® Dielectric Waterway, or Victaulic Clearflow Dielectric Waterway.

B. Flange for 2 1/2 Inch and Larger: ASTM F 1545, insulating flange union per companion, 1/2 flange union with bolt insulators, dielectric gasket, bolts and nuts. Capital Series F, Epco, or Victaulic Clearflow Dielectric Waterway.

C. Ratings: Select temperature and pressure applicable for the systems in which they are installed.

2.5 BACKFLOW PREVENTERS

A. Reduced Pressure Principle Backflow Assembly (RPZ): ASSE 1013, 175 psig working pressure, bronze body and working parts for 2 inch and smaller and cast iron body for 2-1/2 inch and larger, stainless steel springs, with drain funnel. Lead free. Include ball valves for 2 inch size and smaller and outside screw and yoke gate valves for 2-1/2 inch and larger on inlet and outlet, strainer on inlet, test cocks, and relief valve.

B. Double Check Valve Assembly (DCVA): ASSE 1015, 175 psig working pressure, bronze body for 2 inch and smaller and cast iron body for 2-1/2 inch and larger, 2 spring-loaded check valves, 2 OS&Y gate valves, and 4 test cocks. Lead free. Serviceable without removal from piping.

C. Pressure Vacuum Breaker Assembly (PVB): ASSE 1020,150 psig working pressure, bronze body, assembly with tee or lever handle ball valve, test cocks, and replaceable seats

D. Spill Proof Vacuum Breaker Assembly (SVB): ASSE 1056, 150 psig working pressure, bronze body, assembly with tee handle ball valves and test cock.

E. Hose Connection Vacuum Breakers (HBAVB): ASSE 1011, nickel plated, nonremovable, with manual drain and garden-hose threads on outlet complying with ASME B1.20.7. Units attached to rough-bronze-finish hose connections may be rough bronze.

F. Manufacturers: Watts, no substitutions, as listed in “Backflow Prevention Assemblies Approved for Installation in Washington State with amendments”.

2.6 Y-TYPE STRAINERS

A. Description: Line size of connecting piping with ends matching piping system materials. Select strainers for minimum 125 psi working pressure. Include ASTM A 666 Type 304 stainless steel screens, unless specified otherwise, with 3/64 inch perforations at 233 per sq. in. and blowout connection with ball valve and capped nipple or gate valve with plug.

1. Threaded or Solder Ends, 2 Inch and Smaller for Copper Pipe: Cast bronze body with brass screen.
2. Flanged Ends, 2-1/2 Inch and Larger: Cast-iron body.
3. FDA approved epoxy coating on interior and exterior surfaces.
4. Manufacturers: Armstrong Fluid Technology, Watts®, Crane, Hoffman Specialty®, Metraflex, Spirax Sarco, Nibco, or approved.

2.7 BASKET STRAINERS

A. Description: Cast iron body with bolted cover, flanged connections, and drain plug. Select strainer for 125 psi working pressure. Include Type 304 stainless steel screen with 3/64 inch perforations for 2 and 3 inch sizes and 1/8 inch perforations for 4 inch and larger sizes. Interior of body with FDA approved epoxy coating.

B. Manufacturers: Watts No. 97FB-CI, Spirax Sarco, Metraflex, or approved.

2.8 WATER METERS

A. Positive Displacement Type, 2-1/2 Inch and Smaller: Electrical contact type with nutating disc, and non-resettable mechanical totalizing register with pulse generator. Bronze casing with Ryton disc and ball for 150 psig working pressure. AWWA C700. Accuracy plus or minus 0.5 percent of flow rate. Repeatability plus or minus 0.25 percent of flow rate. Registration in gallons. Screwed end connections. Badger Meter Inc. or approved.

B. Ultrasonic Type, 2 Inch and Larger: Ultrasonic metering type with pulse generator. Grade 316 stainless steel through. No moving parts. 10 year battery life minimum. Active leak, theft, backflow, rate of flow and battery life indicator integrated into BACnet protocol. Working pressure to 175 PSI with working temperature of 32-122F. AWWA C701, Class II, and certified to NSF 61 and NSF 372. Registration in gallons. Include downstream test plug and flanged end connections. Master Meter Octave, ONICON F-3100s, Modmag M4000 series or approved.

C. Pulse Generator: Include pulsing generator for connection to the Direct Digital Control (DDC) system specified in Section 230900. Output pulse generator 3-wire mercury wetted single pole, double throw contact. Pulse generator calibrated such that maximum digital output of 6 pulses per second shall correspond to maximum rating of meter. In lieu of pulse generator, meter may be equipped with internal components that communicate via RS 232 or RS 485 to DDC system. Internal components calibrated as required for pulse generator.

2.9 TRAP PRIMERS

A. Electronic Type: Factory assembled unit with electronic module, 24 V transformer, solenoid valve, and integrated strainer, ball valve, brass atmospheric vacuum breaker, multiport distribution manifold, and interconnecting piping. Assembly mounted in a galvanized steel enclosure with cover for surface or recessed installation. Recessed shall be provided in occupied areas. Surface is only allowed in mechanical rooms. ASSE 1044. Zurn Z1020, Precision Plumbing Products (P.P.P.), or approved.

2.10 PIPING SPECIALTIES

A. Pipe Sleeves: Comply with requirements in Section 230510.

B. Pipe Hangers and Supports: Comply with requirements in Section 232116.

C. Thermometers and Pressure Gages: Comply with requirements in Section 232116.

D. Pipe Escutcheons: Comply with requirements in Section 232116.

E. Pipe Wrap: Comply with requirements in Section 232116.

F. Y-Type Strainers: Comply with requirements in Section 232116.

G. Water Hammer Arresters: Factory-sealed shock arresters with direct action bellows, rated in accordance with Plumbing Drainage Institute Standard P.D.I. WH-201 Standard or ASSE 1010. Jay R. Smith, Hydrotrol, Josam, Zurn, or approved.

H. Non-Potable Water Signage:

1. Comply with requirements of UPC for non-potable water piping systems and fixtures.
2. Signage shall state: “CAUTION: NON-POTABLE WATER. DO NOT DRINK”.
3. Obtain approval of signage shape, size, and location from the AHJ prior to installation.

PART 3 - EXECUTION

3.1 INSPECTION

A. General: Verify installation conditions as satisfactory to receive the Work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

3.2 PREPARATION

A. Field Measurements: Field verify locations of new and existing work prior to commencing the Work of this section.

B. Protection: Protect surrounding areas and surfaces to preclude damage from the Work of this section.

3.3 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

A. General: Install, apply, erect, and perform the Work in accordance with Article “Quality Assurance” provisions, specifications, and manufacturer’s installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

B. Do not cover up or enclose work until inspected and approved. If in non-compliance, uncover work, remove, and provide new to satisfaction of the A/E at no additional cost to the Owner.

3.4 PIPING INSTALLATION

A. General:

1. Install piping, fittings, and appurtenances in accordance with recognized industry practices which will achieve permanently leakproof piping systems and capable of performing each indicated service without piping failure.
2. Install each run with minimum joints and couplings, but with adequate and accessible unions or flanges for disassembly and maintenance replacement of valves and equipment.
3. Reduce sizes (where indicated) by use of reducing fittings. Bushings not acceptable.
4. Seal pipe penetrations through walls and floors with resilient sealant specified in Section 230548.

B. Align piping accurately at connections, with 1/16 inch misalignment tolerance.

C. Install pipe generally sloped to permit drainage at low points, free from sags, bends, and traps, and in a manner to conserve space for other work. Refer to other sections for specific installation requirements.

D. Location of Piping:

1. Piping plans, sections, details, and diagrams are diagrammatic indicating general arrangement of piping installation. Locate piping and include offsets to avoid interference with building structural members, equipment, building openings, light fixtures, ductwork, electrical work, and other obstructions.
2. Arrange piping to allow access for operation, service, disconnection, and removal and replacement of valves, fixtures, and equipment.
3. In general, maintain the maximum possible headroom in ways of egress, including pedestrian walkways and maintenance aisles, minimum headroom of 6’-8” from floor to bottom of any component.
4. Within buildings, conceal piping in walls and chases and above ceilings except where indicated in the Contract Documents to remain exposed. Do not cover or enclose work until completely inspected and approved by the AHJ. Should Work be covered or enclosed prior to inspections and approvals, uncover work as directed by the A/E. After Work has been inspected and approved by the AHJ, make repairs and replacements with materials as necessary to obtain approval of the A/E at no additional cost to the Owner.
5. Route piping parallel to column lines and perpendicular to floor unless indicated otherwise.

E. Flexible Tubing: Install in sleeves below concrete slabs on grade for routing of services to kitchen and laboratory island fixtures and remote equipment.

F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

G. Install fittings for changes in direction and branch connections. Install concrete thrust blocks and restraining rods for ductile iron fittings.

H. Install piping to allow application of insulation.

I. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

J. Clean interior of piping before making joints. Maintain cleanliness of piping throughout installation. Install caps or plugs on open ends of cleaned piping.

K. Install pipe supports in accordance with MSS SP-69 and Section 232116, whichever is more stringent.

L. Install hot and cold water piping runouts to fixtures of sizes indicated but in no case smaller than required by applicable plumbing code. Limit dead legs to maximum 5 pipe diameters. Connect hot water circulating system within 5 feet of fixture and bank of fixtures or as indicated on the Drawings.

M. Install isolation valves at major toilet groups and as indicated on the Drawings.

N. Install balancing valves specified in Section 221120 on domestic hot water water recirculating systems at branch connections to mains.

O. Install water meter on hydronic piping system water make-up pipe.

P. Water Hammer Arresters:

1. Install in accordance with Plumbing Drainage Institute Standard P.D.I. WH-201 or ASSE 1010 recommendations. Install at ends of hot and cold water pipes serving 2 or more fixtures and at solenoid valves, dishwashers, clothes washers, and other equipment having quick closing valves. Install with shutoff valve on inlet to water hammer arrester.
2. Furnish and install access doors as specified in Section 230510 where water hammer arresters are concealed within or above general construction. Group multiple water hammer arresters to be accessible through a common access door.

Q. Install non-potable water signage.

3.5 SOLDERED AND BRAZED JOINTS

A. Comply with applicable provisions of ASTM B 828 or “Copper Tube Handbook” by CDA for soldered joints and “Brazing Handbook” by AWS for brazed joints.

B. Cut ends square and remove fins and burrs. Replace dents and damaged tubing with new tubing.

C. Remove grease and oil from joints by wiping with clean cloth saturated with suitable chemical solvent. Clean with emery cloth.

D. After cleaning, apply non-corrosive flux, apply heat and material and hold joint rigidly until hardened.

E. Wipe excess material from exterior of joint before hardening.

F. Before soldering and brazing, remove stems and washers of valves.

G. Braze 2-1/2 inch and larger piping unless copper press fitting couplings are used.

3.6 COPPER PRESS FITTING COUPLINGS

A. Use manufacturer-recommended tool and procedure. Leave insertion marks on pipe after assembly.

3.7 DIELECTRIC UNIONS

A. Install at the Following Locations:

1. At black and galvanized steel piping connections to copper tubing.
2. At black steel piping connections to copper headers for coils installed in air handling units, fan coil units, air terminal boxes, and duct mounted heating and cooling coils.
3. At black steel piping connections to bronze valves and similar devices.

3.8 SOLVENT CEMENT JOINTS

A. Clean and dry joining surfaces.

B. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. CPVC Piping: ASTM D 2855.

3.9 MECHANICAL EQUIPMENT CONNECTIONS

A. Connect hot and cold water piping to mechanical equipment as indicated on the Drawings. Comply with equipment manufacturer's installation instructions. Install shutoff valve and union for each connection and drain valve on drain connection. Locate unions to allow removal of equipment without piping disassembly beyond union.

3.10 BACKFLOW PREVENTERS

A. Install in accordance with "Backflow Prevention assemblies Approved for Installation in Washington State". Install maximum 5 feet above finished floor.

B. Route drain from funnel drain to nearest floor receptor, mop sink, or other approved point of termination. Avoid running pipe across walkways.

3.11 CLEANING AND INSPECTING

A. Clean exterior surfaces of installed piping systems of superfluous materials, and prepare for application of specified coatings (if any).

B. Inspect each run of each system for completion of joints, supports, and accessory items.

C. Inspect pressure piping in accordance with procedures of ASME B31.1 and ASME B31.9

3.12 PRESSURE TESTING

A. Provide equipment and apparatus necessary for tests. Make tests in presence of the A/E. Notify the A/E at least 48 hours before expected tests.

B. Test piping systems before insulation has been applied, and before backfilling.

C. Test Pressures and Duration: Test piping systems at pressure of 1-1/2 times design working pressure or at 100 psig, whichever is greater. Maintain test pressure for sufficient time to permit complete inspection of system under test. Minimum 2 hour duration. Test in sections and test entire system when completely installed.

D. Test Procedure:

1. Before tests, remove or valve off from the system gages, traps, pressure reducing valves, pumps, and other apparatus which may be damaged by test pressure.
2. Install calibrated test pressure gage in system to observe any loss in pressure.
3. Test piping at metal temperature greater than 35 F.
4. Open vents, and other connections which can serve as vents, during filling so that air is vented prior to applying test pressure to system.

E. Testing Media Requirements:

1. Use clean, fresh city water for hydrostatic testing. Water temperature shall be not less than 60 F and not greater than 100 F.
2. Drain water immediately after hydrostatic testing. Vent system while draining to avoid creating a vacuum.

F. Test Repairs:

1. Remove materials such as gaskets and bolts damaged during tests and flushing and provide new components.
2. Use new gaskets each time a flanged joint is made up.
3. Repair defects which develop during testing and retest piping systems until they show no defect or weakness and are tight. Do not use chemicals, stop-leak compounds, mastics, or other temporary repair methods.

G. Test Records: Make and submit records for each piping installation. Include copies in the Operations and Maintenance Manual. Include at a minimum, the following items:

1. Date of test.
2. Description and identification of piping tested.
3. Test fluid.
4. Test pressure.
5. Test duration.
6. Remarks to include such items as: Leaks (type, location); repairs made on leaks.
7. Signature and date of person witnessing the test.
8. Certification by the Contractor.

H. Systems Which Connect to Existing Piping: Isolate new piping system from existing system by the closest valve or valves to the existing system.

3.13 EXTERIOR PIPING INSTALLATION

A. Install exterior water service piping in compliance with local governing regulations.

3.14 STERILIZATION AND FLUSHING OF DOMESTIC WATER PIPING

A. After completion of water piping installation, but prior to connection to existing mains, flush system. Take sample of water from system to determine compliance with Health Department standards. Obtain necessary tests from governing Health Department. If sample is not in compliance, perform sterilization.

B. Sterilize for eight hour contact time with 50 parts per million chlorine concentration. Open valves several times. Follow by flushing with clean water until residual chlorine is less than 0.2 parts per million. Sterilizing non-potable water piping not required.

C. Comply with requirements of ASHRAE Standard 188 as it relates to “Requirements for Building Water Systems” and “Requirements for Designing Building Water System” which include procedures for flushing and disinfection to meet the requirements of AWWA C651 or AWWA C652 or with requirements of applicable national, regional, and local regulations, whichever is more stringent.

D. After flushing and sterilization are complete, conduct tests to determine compliance with Health Department standards for sterilization results. If pipe system is found to be contaminated, correct defects and perform additional flushing and sterilization until satisfactory results are obtained.

E. Submit written certification of flushing and sterilization with approved by the AHJ.

3.15 PLUMBING SYSTEMS TRAINING

A. Comply with requirements in Section 230810.

3.16 COMMISSIONING

A. Equipment and systems referenced in this section shall be commissioned per Section 230800. The Contractor has specific responsibilities for scheduling, coordination, test development, testing and documentation.

END OF SECTION 221116

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Description: The Work includes valves and associated appurtenances for plumbing systems. Valves specific to a single system are specified in that particular section.

B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to the Work in this section.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.

B. Codes and Standards:

1. ANSI/ISEA Z358.1, American National Standard for Emergency Eyewash and Shower Equipment.
2. ASME B31.1, Power Piping.
3. ANSI/ISEA Z358.1, American National Standard for Emergency Eyewash and Shower Equipment.
4. ASSE 1017, Performance Requirements for Temperature Actuated Mixing Valves for Hot Water Distribution Systems.
5. ASSE 1069, Performance Requirements for Automatic Temperature Control Mixing Valves.
6. ASSE 1070, Performance Requirements for Water Temperature Limiting Devices.
7. ASSE 1071, Performance Requirements for Temperature Actuated Mixing Valves for Plumbed Emergency Equipment.
8. ASTM A 126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
9. ASTM A 536, Standard Specification for Ductile Iron Castings.
10. ASTM B 61, Standard Specification for Steam or Valve Bronze Castings.
11. ASTM B 62, Standard Specification for Composition Bronze or Ounce Metal Castings.
12. ASTM B 283, Standard Specification for Copper and Copper-Alloy Die Forgings (Hot Pressed).
13. MSS SP-67, Butterfly Valves.
14. MSS SP-70, Gray Iron Gate Valves, Flanged and Threaded Ends.
15. MSS SP-71, Gray Iron Swing Check Valves, Flanged and Threaded Ends.
16. MSS SP-80, Bronze Gate, Globe, Angle, and Check Valves.
17. MSS SP-85, Gray Iron Globe and Angle Valves, Flanged and Threaded Ends.
18. MSS SP-110, Ball Valves Threaded, Socket-Welding, Socket Joint, Grooved and Flared Ends.
19. MSS SP-125, Grey Iron and Ductile Iron In-Line, Spring-Loaded, Center-Guided Check Valves.
20. ASTM B 584, Standard Specification for Copper Alloy Sand Castings for General Applications.
21. NSF 61, Drinking Water System Components – Health Effects.

22. NSF 372, Drinking Water Systems Components – Lead Content.
23. UL 873, Standard for Temperature-Indicating and Regulating Equipment.

C. Domestic Water Systems: Products carrying and dispensing water for consumption through drinking and cooking shall be certified by an independent, ANSI-accredited, third party certification organization to requirements of NSF 61 and NSF 372 for 0.25 percent maximum lead content for wetted component base material.

1.3 SUBMITTALS

A. Comply with requirements in Division 01 and Section 230500.

B. Product Data: Submit manufacturer's technical product data and maintenance data for the following:

1. Gate valves.
2. Ball valves.
3. Swing check valves.
4. Non-slam check valves.
5. Butterfly valves.
6. Drain valves.
7. Balancing valves.
8. Relief valves.
9. Pressure reducing valves.
10. Vacuum relief valves.
11. Thermostatic mixing valves.
12. Blank copy of start-up test and report form.

C. Test Reports:

1. Field start-up and test reports.
2. Submit completed copy of report and include copy in the Operations and Maintenance Manual.

D. Certificates: Compliance with NSF 61 and NSF 372 for no-lead/lead-free.

PART 2 - PRODUCTS

2.1 GENERAL

A. Furnish factory-fabricated valves recommended by manufacturer for use in service indicated. Furnish valves of types and pressure ratings indicated but rated at not less than 125 psig WSP to comply with installation requirements. Furnish sizes as indicated with connections which properly mate with pipe, tube, and equipment connections. Where more than one type is indicated, selection is the Contractor's option. Refer to other sections for higher working steam pressures.

B. Rubber, plastic, and silicone gaskets not acceptable for domestic water systems.

C. Press Joint Valves: Use with press joint copper piping systems as specified in Section 221116 for sizes 1/2 inch through 2 inch.

D. Manufacturers: Fairbanks, Hammond Valve, Red-White Valve Corp., Jenkins, Milwaukee Valve Co., NIBCO, Powell, Stockham, Walworth Valves, DFT® Inc, Metraflex Co., Jomar Group, or Apollo®/Conbraco Industries, Inc.

2.2 GATE VALVES

A. General: Select valves designed for repacking under pressure when fully opened, equipped with packing suitable for intended service. Select valves designed so back seating protects packing and stem threads from fluid when valve is fully opened. Equip with gland follower. Comply with the following standards:

1. Bronze Valves: MSS SP-80.
2. Cast Iron Valves: MSS SP-70.

B. 2 inch and Smaller: Bronze, solid bronze wedge disc, nonrising stem, screwed or soldered joint ends, union bonnet, ASTM B 62.

C. 2-1/2 inch and Larger: Cast iron body, solid wedge disc, bronze trim, flanged, OS&Y, bolted bonnet, ASTM A 126. FDA epoxy coating on internal components acceptable.

2.3 BALL VALVES

A. General: Select with port area equal to or greater than connecting pipe area, include seat ring designed to hold sealing material. Comply with MSS SP-110.

B. Bronze body, 600 pound, chrome plated ball and stainless steel stem, full port, screwed or solder joint ends, 2 piece construction, lever handle, Teflon seat and seal, memory stop, ASTM B 61, ASTM B 62, or ASTM B 584. Include extended stem, protective sleeve, and fully adjustable memory stop after insulation is applied where valves are insulated. Lead free, cast iron with epoxy coating on internal components or bronze body with Type 316 stainless steel ball and stem acceptable for sizes 2-1/2 inch and larger.

2.4 GLOBE VALVES

A. General: Select valves designed for repacking under pressure when fully opened, equipped with packing suitable for intended service. Select valves designed so back seating protects packing and stem threads from fluid when valve is fully opened. Equip with gland follower. Comply with the following standards:

1. Bronze Valves: MSS SP-80.
2. Cast Iron Valves: MSS SP-85.

B. 2 inch and Smaller: Bronze, bronze disc and stem, screwed or soldered joint ends, integral seat and screw-in bonnet, asbestos free packing and gasket, ASTM B 62.

C. 2-1/2 inch and Larger: Cast iron body, cast iron disc, bronze trim, full port, flanged, OS&Y, bolted bonnet, asbestos free packing and gasket, ASTM A 126. FDA epoxy coating on internal components acceptable.

2.5 SWING CHECK VALVES

A. General: Construct valves of pressure castings free of impregnation materials. Include stop plug as renewable stop for disc hanger. Construct disc and hanger as separate parts, with disc free to rotate. Support hanger pins on both ends by removable side plugs. Comply with the following standards for design, workmanship, material and testing:

1. Bronze Valves: MSS SP-80.
2. Cast Iron Valves: MSS SP-71.

B. 2 inch and Smaller: Bronze, screwed cap, bronze or brass swing disc, Y-pattern, screwed or solder joint ends, ASTM B 62.

C. 2-1/2 inch and Larger: Cast iron body, flanged, bolted cap, swing pattern, ASTM A 126, renewable cast iron disc with bronze disc face ring and seat to ASTM B 584 except valves larger than 4 inch may be furnished with cast iron disc to ASTM A 126. FDA epoxy coated internal surfaces acceptable.

2.6 NON-SLAM CHECK VALVES

A. For vertical upward fluid flow. Comply with the following standards:

1. Bronze Valves: MSS SP-80.
2. Cast Iron Valves: MSS SP-125.

B. 2 inch and Smaller: Brass body, screwed or solder joint ends, Type 304 stainless steel or bronze spring, brass disc holder, PTFE or Buna-N disc, ring, ASTM B 61 or ASTM B 62. Cast iron valves, ASTM A 126, acceptable.

C. 2-1/2 inch and Larger: Cast iron body, clear or full waterway, globe style, flanged, bronze trim, stainless steel spring and screw, ASTM A 126. FDA epoxy coated internal surfaces acceptable.

2.7 BUTTERFLY VALVES

A. Comply with MSS SP-67.

B. 6 inch and Larger: Ductile iron body, lug type, Type 316 stainless steel disc, molded-in EPDM seals, O-ring stem seals, spring loaded latching device. Bubble tight to 165 psig. Notched plate lever handle operator up to 3 inch size. Gear operator with hand wheel for sizes 4 inch and larger. Memory stop for operators. Include extended neck to clear adjacent pipe insulation and where valves are insulated. FDA epoxy coated internal surfaces acceptable.

2.8 DRAIN VALVES

A. Bronze body, composition disc, 3/4 inch handwheel, screwed or solder joint ends hose thread outlet with cap. At the Contractor's option, full port ball valve acceptable.

2.9 BALANCING VALVES

A. Description: Valves for variable orifice flow measurement and balancing. Positive shutoff with memory stop indicator.

B. Construction: Brass alloy body ASTM B 283, Type 304 stainless steel ball, brass readout valves with EPT check valves. EPDM stem "O" ring, solder connections, 360 degree handwheel adjustment, and 1/4 inch NTP tapped and plugged drain port.

C. Manufacturers: Bell & Gossett Circuit Setter® Plus Model RF-LF or CB-RF Series, Victaulic Co., or approved.

2.10 RELIEF VALVES

A. General: CSA rated. Select for capacity to exceed rating of connected equipment. Watts Water Technologies Inc. No. 100XL for temperature and pressure applications and Watts Water Technologies Inc. No. 174A for pressure only applications, Cash Acme® or approved.

2.11 PRESSURE REDUCING VALVES

A. General: Water regulators with factory or field installed strainer, screwed or flanged ends, Buna-N diaphragm, and stainless steel internal components.

B. 3 inch and Smaller: Brass body with screwed ends. Include factory strainer, built-in bypass feature, and EDPM valve disc, 300 psig maximum working pressure, 25 to 75 adjustable reduced pressure range. Watts Water Technologies Inc. No. LFN223BS, Cash Acme®, Zurn-Wilkins, or approved.

C. 4 inch and Larger: Ductile iron body with flanged ends, ASTM A 536. Main valve with, stainless steel trim for sizes through 8 inch and bronze trim for 10 inch size, 250 psig operating pressure. Include pilot operated diaphragm valve with 20 to 175 psig reducing control pressure, and copper/brass tubing connections. Interior of body with NSF listed epoxy lining and coating. Watts Water Technologies Inc. No. F115 for globe pattern and No. F1115 for angle pattern, Cash Acme®, Zurn-Wilkins, or approved.

2.12 VACUUM RELIEF VALVES

A. Low lead brass body, high heat resistant disc. Valve closes quickly and tightly under pressure and opens on vacuum of not over 1/2 inch mercury. Watts Water Technologies Inc. No. N36 or approved.

2.13 THERMOSTATIC MIXING VALVES

A. General: Self-contained thermostatic mixing valve, factory assembled and tested, with solid bimetal thermostat to control hot and cold water intake and to compensate for supply temperature and pressure fluctuations. Comply with ASSE 1070 for single fixtures and ASSE 1069 for multiple fixtures served by valve. Thermostatic mixing valves with paraffin based temperature control acceptable.

B. Construction: Rough bronze finish with bronze, brass, and stainless steel internal components.

C. Components:

1. Integral wall support and plastic handle with locking temperature regulator.
2. Adjustable high temperature limit stop set for 120 F.
3. Outlet ball valve and pressure gage.
4. Union angle check stops on inlets.
5. Color coded dial thermometer with directional indicators.
6. Cabinet: recessed when exposed in public spaces.

D. Manufacturers: Leonard Valve Co. Type TM, Powers LFMM 430, Acorn Engineering Co. Model MV 17, or approved.

2.14 VALVE OPERATORS

A. Valves in Mechanical and Boiler Rooms and Above Suspended Ceilings: Include valve with chain operator complete with sprocket rim and chain guide and hot dipped galvanized chain for valves 4 inch and larger in mechanical rooms and boiler rooms and for valves 2-1/2 inch and larger where installed above suspended ceilings.

PART 3 - EXECUTION

3.1 INSPECTION

A. General: Verify installation conditions as satisfactory to receive the Work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

3.2 PREPARATION

A. Field Measurements: Field verify locations of new and existing work prior to commencing the Work of this section.

B. Protection: Protect surrounding areas and surfaces to preclude damage from the Work of this section.

3.3 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

A. General: Install, apply, erect, and perform the Work in accordance with Article “Quality Assurance” provisions, specifications, and manufacturer’s installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

3.4 INSTALLATION

A. Install valves where required for proper operation of piping and equipment, including valves in branch lines to isolate sections of piping. Locate valves in accessible locations. Install gate valves 6 inch and larger with separate support so that valve weight is not imposed on adjacent piping.

B. Valve Stem Position:

1. Gate, Globe, and Ball Valves: Install horizontal or above.
2. Butterfly Valves: Install with stem in vertical-up position, horizontal, or at 45 degree angle between horizontal and vertical-up. Vertical-down position acceptable with manufacturer’s submittal or factory written qualified statement that performance or servicing will not be affected.

C. Check Valves:

1. Swing type check valves installed in vertical pipes not acceptable.
2. Install non-slam check valves in pump discharge pipes and in vertical pipes.

D. Install isolation valves where indicated on the Drawings and in the following locations:

1. Branch lines.
2. Branch mains.
3. At connections to equipment including coils and control valves and similar items.

E. Install drain valves at low points of plumbing systems and as indicated on the Drawings.

F. Install balancing valves with reducers upstream and downstream of valve connections. Install valves with straight pipe upstream and downstream as required by manufacturer’s installation instructions.

G. Install pressure reducing valves with either factory furnished or field furnished low pressure Y-type strainer as specified in Section 232116.

H. Install isolation valves upstream of balancing valves.

I. Install valve operators with chains for valves located with horizontal centerline more than 7 feet above floor and where installed with horizontal centerline more than 6 inch above suspended ceilings. Terminate chain 4 feet above floor and 6 inch above ceiling.

J. Install 12 inch long orange colored 1/2 inch wide surveyors tape on valves located above ceilings.

K. Furnish and install access doors as specified in Section 230510 where valves are concealed within or above general construction. Group multiple valves to be accessible through a common access door.

3.5 PLUMBING SYSTEMS TRAINING

A. Comply with requirements in Section 230810.

3.6 COMMISSIONING

A. Equipment and systems referenced in this section shall be commissioned per Section 230800. The Contractor has specific responsibilities for scheduling, coordination, test development, testing and documentation.

END OF SECTION 221120

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Description: The Work includes plumbing pumps and associated appurtenances.

B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to the Work in this section.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.

B. Codes and Standards:

1. ASTM A 48, Standard Specification for Gray Cast Iron Castings.
2. ASTM B 61, Standard Specification for Steam or Valve Bronze Castings.
3. NSF 61, Drinking Water Systems Components – Health Effects.
4. NSF 372, Drinking Water Systems Components – Lead Content.
5. UL 508, Standard for Industrial Control Equipment.
6. UL 778, Motor-Operated Water Pumps.

1.3 SUBMITTALS

A. Comply with requirements in Division 01 and Section 230500.

B. Product Data: Submit manufacturer's technical product data and maintenance data for the following. Include each type of piping, fittings, and associated appurtenances.

1. Domestic hot water circulating pumps.
2. Blank copy of start-up test and report form.

C. Test Reports:

1. Start-up and field test reports.

PART 2 - PRODUCTS

2.1 SELECTION

A. Pumps are selected in mid-range of available impeller diameters for a given pump, at no less than 2/3 flow rate at maximum efficiency, and with a drive motor sized to operate non-overloading at any point on the pump curve for the impeller selected.

B. Pump casing shall be sized large enough to accommodate impeller at least 1 cataloged diameter larger than size of impeller to be furnished.

C. Pump shall have maximum 15 feet per second discharge velocity.

2.2 DOMESTIC HOT WATER CIRCULATING PUMPS

A. Description: Centrifugal, in-line, close-coupled, single stage, electric motor-driven, suitable for domestic water. Certified and labeled to NSF 61 for potable drinking water.

B. Construction: Pump volute and impellor Type 316L stainless steel construction, screwed connections or flanged ends with screwed companion flanges. Include drain and vent plug.

C. Shaft Seals: Mechanical, Viton, carbon on silicon carbide.

D. Motor: NEMA Standard open drip proof, permanent split-capacitor with thermal overload protection and permanently lubricated ball bearings, single speed. Shaft material Type 316 stainless steel. Comply with requirements in Section 230513.

E. Manufacturers: Bell & Gossett 3530 Series Armstrong Fluid Technology, Grundfos Pumps, or approved.

PART 3 - EXECUTION

3.1 INSPECTION

A. General: Verify installation conditions as satisfactory to receive the Work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

3.2 PREPARATION

A. Field Measurements: Field verify locations of new and existing work prior to commencing the Work of this section.

B. Protection: Protect surrounding areas and surfaces to preclude damage from the Work of this section.

3.3 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

A. General: Install, apply, erect, and perform the Work in accordance with Article “Quality Assurance” provisions, specifications, and manufacturer’s installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

3.4 INSTALLATION OF PUMPS

A. General: Support pumps and piping separately so piping is not supported by pumps.

B. In-Line Pumps: Provide rod hangers to support independently from piping system with access to oil cups, service, and maintenance. Mount maximum of 5'-0" above floor. Comply with requirements in Section 230510 for rod hangers, Section 230548 for vibration isolators, and Section 230550 for seismic restraints.

3.5 PLUMBING SYSTEMS TRAINING

A. Comply with requirements in Section 230810.

3.6 COMMISSIONING

A. Equipment and systems referenced in this section shall be commissioned per Section 230800. The Contractor has specific responsibilities for scheduling, coordination, test development, testing and documentation.

END OF SECTION 221123

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Description: The Work includes building drainage piping and associated appurtenances.

B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to the Work in this section.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.

B. Codes and Standards:

1. Applicable plumbing code pertaining to materials, products, and installation of soil, waste, vent, and storm drain piping.
2. AASHTO, American Association of State Highway and Transportation Officials.
3. ACI 318, Building Code Requirements for Reinforced Concrete.
4. ASME A112.1.2, Air Gaps in Plumbing Systems (For Plumbing Fixtures and Water-Connected Receptors).
5. ASME A112.6.3, Floor and Trench Drains.
6. ASME A112.21.2, Roof Drains.
7. ASME A112.36.2, Cleanouts.
8. ASME B16.3, Malleable Iron Threaded Fittings: Classes 150 and 300.
9. ASME B16.12, Cast Iron Threaded Drainage Fittings.
10. ASME B16.23, Cast Copper Alloy Solder Joint Drainage Fittings (DWV).
11. ASME B16.29, Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings (DWV).
12. ASSE 1021, Drain Air Gaps for Residential Dishwasher Applications.
13. ASSE 1050, Performance Requirements for Stack Air Admittance Valves for Sanitary Drainage Systems.
14. ASSE 1051, Performance Requirements for Individual and Branch Type Air Admittance Valves for Sanitary Drainage Systems.
15. ASSE 1072, Barrier Type Floor Drain Trap Seal Protection Devices.
16. ASTM A 53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
17. ASTM A 74, Standard Specification for Cast Iron Soil Pipe and Fittings.
18. ASTM A 106, Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
19. ASTM A 615, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
20. ASTM A 888, Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
21. ASTM A 1064, Standard Specification for Carbon-Steel Welded Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
22. ASTM B 306, Standard Specification for Copper Drainage Tube (DWV).

23. ASTM C 564, Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
24. ASTM C 890, Standard Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures.
25. ASTM C 1277, Standard Specification for Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings.
26. ASTM C 1540, Standard Specification for Heavy-Duty Shielded Couplings Joining Hubless Cast Iron Sewer Pipe and Fittings.
27. ASTM C 1613, Standard Specification for Precast Concrete Grease Interceptor Tanks.
28. ASTM D 1527, Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe, Schedules 40 and 80.
29. ASTM D 2235, Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.
30. ASTM D 2321, Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
31. ASTM D 2661, Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings.
32. ASTM D 2672, Standard Specification for Joints for IPS PVC Pipe Using Solvent Cement.
33. ASTM D 2680, Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly (Vinyl Chloride) (PVC) Composite Sewer Piping.
34. ASTM D 2751, Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings.
35. ASTM D 2855, Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings.
36. ASTM F 402, Standard Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings.
37. ASTM F 628, Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe With a Cellular Core.
38. AWWA C 110/A 21.10, Standard for Ductile-Iron and Gray - Iron Fittings.
39. AWWA C 111/A 21.11, Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
40. AWWA C 151/A 21.51, Standard for Ductile-Iron Pipe, Centrifugally Cast.
41. AWWA C 153/A21.53, Standard for Ductile-Iron Pipe Compact Fittings for Water Service.
42. CISPI 301, Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
43. CISPI 310, Specification for Couplings for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
44. FM 1680, Approval Standard for Couplings Used in Hubless Cast Iron Systems for Drain, Waste or Vent, Sewer, Rainwater or Storm Drain Systems Above and Below Ground, Industrial/Commercial and Residential.
45. IGC 237, IAPMO Guide Criteria for High Pressure Stainless Steel Shielded Couplings for Use with Hubless Cast Iron Soil Pipe and Fittings.
46. NSF 14, Plastic Piping System Components and Related Materials.

1.3 SUBMITTALS

A. Comply with requirements in Division 01 and Section 230500.

B. Product Data: Submit manufacturer’s technical product data and maintenance data for the following.

1. Piping, tubing, and fittings.
2. Cleanouts.
3. Vents through roof.
4. Floor drains.
5. Floor sinks.
6. Roof drains.
7. Piping specialties.

C. Shop Drawings: Comply with requirements in Section 230500.

1.4 DEFINITIONS

A. The term “floor receptor” may be used on the Drawings. This term means “floor drain”, “funnel floor drain”, “floor sink”, or similar device as applicable.

PART 2 - PRODUCTS

2.1 GENERAL

A. Furnish products of sizes, ratings, and characteristics indicated which comply with manufacturer's standard materials, design, and construction in accordance with published product information. Furnish quantity of piping and appurtenances required for complete installation.

B. Piping specified in this section apply to the following systems:

1. Waste and vent.
2. Rainleader and overflow rainleader.
3. Indirect drain for equipment, air vent, cooling coil condensate drains and similar applications.

2.2 MANUFACTURERS

A. Drains, Cleanouts, and Miscellaneous: Jay R. Smith Mfg. Co., Josam Co., Wade Mfg. Co., Zurn Wilkins, Watts Water Technologies, Highland Tank, Eric’sons, or approved. Jay R. Smith model numbers are listed.

2.3 PIPING, TUBING, AND FITTINGS

A. Piping Materials:

1. Cast Iron:

a. Pipe and Fittings: Service weight cast iron soil pipe marked with collective trademark of Cast Iron Soil Pipe Institute (CISPI) and be listed by NSF International. ASTM A 888 or CISPI No. 301. AB&I Foundry, Charlotte Pipe and Foundry Co., or Tyler Pipe. No substitutions.

b. Hub and Spigot Joints: ASTM A 74, compression gasketed type, specifically designed for pipe and fittings used or caulked type. Gaskets ASTM C 564, rubber.
c. Hubless Joints: ASTM A 888 or CISPI No. 310 for heavy duty and standard duty couplings. Tested to ASTM D 3677.

1) Heavy Duty Couplings for Underground Pipe and Fittings and Rainleaders and Overflow Rainleaders: Comply with Factory Mutual Research Standard FM 1680 Class 1 and ASTM C 1540, Type 304 stainless steel housing or shield and stainless steel clamps, neoprene gasket with sealing rings to ASTM C 564 or ASTM C 1277. Clamp-All HI TORQ 125, Anaco-Husky SD 4000. MG Couplings cast iron split clamps with stainless steel nuts and bolts and neoprene gasket acceptable. No substitutions.
2) Standard Duty Couplings for Above Ground Pipe and Fittings: Comply with ASTM C 1540, Type 304 stainless steel housing or shield and stainless steel clamps, neoprene gasket with sealing rings to ASTM C 564 or ASTM C 1277. Clamp-All HI TORQ 80, or Anaco-Husky HD 2000, Mission Rubber Company LLC HeavyWeight, Ideal Tridon Couplings Heavy Duty, or Tyler Pipe. Thermafit Industries POC.

d. Fittings: ASTM A 74 for hub and spigot piping and ASTM A 888 or CISPI 301, and CISPI 310 for hubless piping.
e. Hubless Joint Restraints: Galvanized steel straps and band clamps. HOLDRITE® 117 Series, or approved.

2. Galvanized Steel:

a. Pipe: Standard weight or Schedule 40, ASTM A 53 or ASTM A 106.
b. Fittings:

1) Drainage Fittings: Galvanized cast iron drainage pattern, screwed, ASME B16.12.
2) Vent Fittings: 150 pound galvanized malleable iron, screwed, ASME B16.3.

3. Copper:

a. Pipe: Type DWV, hard drawn drainage tubing, ASTM B 306.
b. Fittings: Cast copper, ASME B16.23 or wrought copper, ASME B16.29, solder joint.

B. Above Ground Drain, Waste, Vent, Rainleader, and Overflow Rainleader Piping:

1. 1-1/2 Inch and Smaller: Galvanized steel, cast iron, or copper.
2. 2 Inch and Larger: Cast iron.

C. Underground Drain, Waste, Vent, Rainleader, and Overflow Rainleader Piping: Cast iron.

2.4 CLEANOUTS

A. Standard: Fabricate in accordance with ASME A 112.36.2M.

B. Floor Cleanouts (FCO) in Finished Spaces: Coated cast iron body and frame, round adjustable secured nickel-bronze top, taper thread, bronze plug. Include carpet clamping frame where installed in floors with carpet. Verify floor finish with room finish schedule on architectural drawings. Jay R. Smith Figure 4023S.

C. Floor Cleanouts (FCO) in Finished Spaces: Coated cast iron body and frame, square adjustable secured nickel bronze top, with 1/8 inch tile or 1/2 inch terrazzo recess, taper thread bronze plug. Verify floor finish with room finish schedule indicated on architectural drawings. Jay R. Smith Figure 4163S or 4203S.

D. Floor Cleanouts (FCO) in Unfinished Spaces: Coated cast iron body and frame, round adjustable scoriated cast iron top with non-tilt heavy duty top, taper thread, bronze plug. Jay R. Smith Figures 4243S or 4253S.

E. Wall Cleanouts (WCO): Cast bronze plug with taper thread, round stainless steel cover and vandal proof screw. Length of screw to suit installation requirements. Jay R. Smith Figure 4472T.

F. Exterior Cleanout (ECO): Coated cast iron body and frame with extra heavy duty, round adjustable scoriated secured cast iron top, taper thread, bronze plug. Jay R. Smith Figure 4223S.

2.5 VENTS THROUGH ROOF

A. Vent Flashings:

1. Dektite flashings (flexible rubber boot flashing) at pipe penetrations through steel or composition roofs.
2. Use 4 pound per square foot seamless lead flashing skirt, minimum of 8 inch extending from pipe, with conical galvanized steel reinforcing boot and counterflashing fitting on built-up roofing.

B. Vandal Proof Vent Caps: Coated cast iron, full size of vent pipe, caulked base connection for cast iron pipes, threaded base for steel pipes with recessed set screw. Jay R. Smith Figure 1748.

2.6 FLOOR DRAINS

A. Standard: Fabricate in accordance with ASME A 112.6.3.

B. FD-1, Floor Drain, Finished Areas: Two-piece coated cast iron body, double drainage flange, reversible flashing collar, weepholes where required, bottom outlet, 5 inch adjustable round nickel bronze strainer, and vandal proof screws. Jay R. Smith Figure 2005.

C. FD-2, Floor Drain, Unfinished Areas: Two-piece coated cast iron body, double drainage flange, reversible flashing collar, weepholes where required, bottom outlet, 7 inch adjustable square nickel bronze strainer, sediment bucket, and vandal proof screws. Jay R. Smith Figure 2005.

D. FFD-1, Funnel Floor Drain: Two-piece coated cast iron body, double drainage flange, reversible flashing collar, weepholes where required, bottom outlet, adjustable square polished

bronze strainer, and 6 inch diameter polished bronze funnel assembly. Jay R. Smith Figure 3510 modified with Figure 3581 funnel.

E. Trap Primer Fittings: Coated cast iron with 1/2 inch threaded inlet tapping. Jay R. Smith Figure 2695.

2.7 FLOOR SINKS

A. Standard: Fabricate in accordance with ASME A 112.6.3.

B. FS-1, Floor Sink without Grate: 12 inch square top, less rim and grate, 8 inch deep 14 gage Type 304 stainless steel receptor, no hub, dome bottom strainer, flange and flashing clamp for above grade installations and wide top flange. Jay R. Smith Figure 3003.

C. FS-2, Floor Sink with Half Grate: 12 inch square top, polished stainless steel half-grate, 8 inch deep 14 gage Type 304 stainless steel receptor, no hub, dome bottom strainer, flange and flashing clamp for above grade installations and wide top flange. Jay R. Smith Figure 3003.

2.8 ROOF DRAINS

A. Standard: Fabricate in accordance with ASME A 112.21.2M.

B. RD-1, Roof Drain: Nominal 16 inch diameter, coated cast iron body, clamp ring with integral gravel stop, roof flange, underdeck clamp, sump receiver, extension, bottom outlet, cast iron dome. Jay R. Smith Figure 1010.

C. ORD-1, Overflow Roof Drain: Coated cast iron body, clamp ring with integral gravel stop, roof flange, underdeck clamp, sump receiver, extension, bottom outlet, cast iron dome, 2 inch high water dam. Jay R. Smith Figure 1080.

D. ON-1, Overflow Roof Drain Nozzle: Polished Nickel body, wall flange with pre-drilled counter-sunk mounting holes, and bird screen. Jay R. Smith Figure 1770.

2.9 PIPING SPECIALTIES

A. Pipe Sleeves: Comply with requirements in Section 230510. Use black steel or cast iron pipe for pipe sizes 6 inch diameter and larger.

B. Pipe Hangers and Supports: Comply with requirements in Section 232116.

C. Pipe Escutcheons: Comply with requirements in Section 232116.

D. Pipe Wrap: Comply with requirements in Section 232116.

PART 3 - EXECUTION

3.1 INSPECTION

A. General: Verify installation conditions as satisfactory to receive the Work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

3.2 PREPARATION

A. Field Measurements: Field verify locations of new and existing work prior to commencing the Work of this section.

B. Protection: Protect surrounding areas and surfaces to preclude damage from the Work of this section.

3.3 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

A. General: Install, apply, erect, and perform the Work in accordance with Article “Quality Assurance” provisions, specifications, and manufacturer’s installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

B. Do not cover up or enclose work until inspected and approved. If in non-compliance, uncover work, remove, and provide new to satisfaction of the A/E at no additional cost to the Owner.

3.4 PIPING INSTALLATION

A. General:

1. Install with uniform pitch of at least 1/4 inch per foot for horizontal waste, rainleader, and overflow rainleader piping, unless otherwise indicated on the Drawings or allowed by the AHJ.
2. Install cast iron soil piping according to CISPI’s “Cast Iron Soil Pipe and Fittings Handbook”.
3. Pitch vents for proper drainage. Vent piping may be installed horizontal if required to avoid conflict with building elements.
4. Joints and Connections:

    a. Bell and Spigot: Neoprene compression seals.
    b. Hubless: Alternately and incrementally tighten clamp bolts to manufacturer’s recommended torque value, using single setpoint torque wrench specifically manufactured for this purpose. Do not use screwdrivers or other types of wrenches. Retorque after 24 hours if required by manufacturer’s installation instructions. Install with hubless fitting restraints at branch openings and changes in direction per CISPI No. 310 for pipe sizes 5 inch and larger.

5. Copper waste piping for urinals not acceptable.
6. Clean interior of piping. Remove dirt and other superfluous material as work progresses.

7. Place plugs in ends of uncompleted piping at end of day or whenever work stops.

B. Above Ground Piping:

1. Support horizontal piping to maintain alignment, prevent grade reversals, and prevent sagging.
2. Support vertical stacks at each floor with riser clamps.
3. Hub and Spigot Piping: Support at 5 feet maximum centers and within 18 inch of each joint. Minimum 1 hanger or support between any 2 joints and fittings.
4. No-Hub Piping: Provide hangers and supports per applicable plumbing code.

C. Underground Piping:

1. Perform trenching and backfilling associated with plumbing installation per requirements in Section 230510.
2. Laying of Hub and Spigot and No-Hub Piping: Install in bedding of trench, graded to provide uniform support for pipe, and to permit joining. Install hubs at upgrade end.
3. Install piping in trenches and not supported on foundation footings or concrete walls.
4. At time of Substantial Completion, video record main waste lines. Include copy of video recording (labeled) in the Operations and Maintenance Manual.

3.5 CLEANOUTS

A. Install waste, rainleader, and overflow rainleader cleanouts at base of stacks and in accordance with requirements in the applicable plumbing code. Full pipe size, 4 inch maximum. Maximum distance between cleanouts shall be 50 foot interval for piping 4 inch and smaller and 100 foot for piping 6 inch and larger.

B. Install floor cleanouts with top cover flush with finished floor surface.

C. Install wall cleanouts in restrooms with greater than 2 water closets and urinals.

D. Install wall cleanout at sinks below trap arm connection.

E. Demonstrate removal of cleanout covers.

3.6 VENTS THROUGH ROOF

A. Locations shown on the Drawings are preliminary. Coordinate final locations with other trades, minimum 10’-0” from outside air intakes.

B. Refer to architectural drawings.

C. Install vandal proof vent caps on each vent pipe passing through roof. Locate base of cap 6 inch above roof surface or higher where required by the applicable plumbing code. Secure set screw.

3.7 EQUIPMENT CONNECTIONS

A. Install soil and waste piping runouts to plumbing fixtures and drains with approved trap and sizes indicated on the Drawings, but in no case smaller than that required by the applicable plumbing code.

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

C. Make gas- and watertight. Use 1 piece special molded gaskets for connections between outlet of fixtures and soil pipe flanges.

D. Install trap where manufacturer does not include trap built into fixture. Install to be removable for servicing and replacement.

E. Coordinate soil, waste, and rainleader piping as necessary to interface with floor drains, floor sinks, and roof drains.

F. Install floor drains and floor sinks in accordance with written manufacturer's instructions at low points of surface areas to be drained or as indicated on the Drawings. Set tops of drains flush with finished floor. Coordinate with architectural drawings. Install trap primer fittings below floor drains and floor sinks so that trap primer line is not installed in concrete floor slab.

G. Secure roof drain domes to roof drain body with minimum 2 stainless steel screws.

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

I. Install condensate drains from cooling coil condensate drains with trap. Terminate with 1 inch air gap over floor drain, floor sink, service sink, outdoors, or as indicated on the Drawings.

3.8 PRESSURE TESTING

A. Test drainage piping in accordance with applicable plumbing code. Comply with requirements in Section 221116. Test by air or water for metal piping and by air for ABS piping.

3.9 PLUMBING SYSTEMS TRAINING

A. Comply with requirements in Section 230810.

3.10 COMMISSIONING

A. Equipment and systems referenced in this section shall be commissioned per Section 230800. The Contractor has specific responsibilities for scheduling, coordination, test development, testing and documentation.

END OF SECTION 221300

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Description: The Work includes water heaters and associated appurtenances.

B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Condition and Division 01 sections apply to the Work in this section.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.

B. Codes and Standards:

1. Applicable energy code.
2. Applicable plumbing code pertaining to materials, products, and installation of plumbing equipment.
3. ASHRAE Standard 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings.
4. ASME BPVC, Boiler Pressure and Vessel Code, Section VIII, Division 01, Rules for Construction of Pressure Vessels.
5. ANSI Z21.10.3, Gas Water Heaters, Volume III, Storage Water Heaters With Input Ratings Above 75,000 Btu Per Hour, Circulating and Instantaneous.
6. NSF 61, Drinking Water System Components - Health Effects.
7. NSF 372, Drinking Water Systems Components – Lead Content.

C. Domestic Water Systems: Products carrying and dispensing water for consumption through drinking and cooking shall be certified by an independent, ANSI-accredited, third party certification organization to requirements of NSF 61 and NSF 372 for 0.25 percent maximum lead content for wetted component base material.

1.3 SUBMITTALS

A. Comply with requirements in Division 01 and Section 230500.

B. Product Data: Submit manufacturer’s technical product data and maintenance data for the following. Indicate accessories where required for complete system and installation instructions.

1. Water heaters, electric.
2. Water heaters, tankless, electric.
3. Expansion tanks.
4. Drain pans.
5. Blank copy of start-up test and report form.

C. Test Reports:

1. Field start-up and test reports.
2. Submit completed copy of report and include copy in the Operations and Maintenance Manual.

1.4 WARRANTY

A. Water Heaters Components: Non-prorated warranty against failure due to defect in material or workmanship for number of years after Substantial Completion date specified for specific water heaters in this section. Warranty shall cover material, labor, and travel time. Make available replacement within 48 hours of initial notification.

PART 2 - PRODUCTS

2.1 WATER HEATERS, ELECTRIC

A. Description: Vertical tank type, commercial-grade, electric water heater.

B. Ratings: UL listed and labeled, certification of compliance with ASHRAE 90.1, ASME labeled, 150 psig working pressure.

C. Construction: Glass lined tank, screw-in or bolt-on immersion elements with incoloy sheathing, replaceable magnesium anode rod, cold water dip tube, round steel enclosure with label, enamel finish, insulation to meet requirements of energy code as adopted by the AHJ.

D. Controls: Hinged control compartment with 120 V control transformer and fusing, magnetic contactors, element fusing per NEC, adjustable immersion style operating thermostats, manual reset high limit switch.

E. Components:

1. CSA rated temperature and pressure safety relief valve selected to exceed rating of water heater.
2. Drain valve.
3. Support legs.

F. Manufacturers: A.O. Smith DRE Series, Rheem Mfg. Corp., State Water Heaters, Bradford White Corp., PVI Industries, Inc., Lochinvar LLC, or approved.

2.2 WATER HEATERS, TANKLESS, ELECTRIC

A. Description: Instantaneous tankless type with flow control capability for undercounter installation.

B. Rating: UL listed and labeled, 150 psig working pressure.

C. Construction: Plastic cover and base.

D. Components:

1. Internal components with heating system, electronic control unit, flow sensor, temperature sensor, high temperature limit cutoff device or system, and wiring block.
2. Components on cover include temperature adjustment rotary switch, power light, and LED temperature display.
3. Brackets for wall mounting.

E. Manufacturers: Stiebel Eltron, Eemax, Chronomite Laboratories™, or approved.

2.3 EXPANSION TANKS

A. Description: Pre-charged tank. Suitable for use in potable and non-potable water systems.

B. Ratings: ASME labeled for sizes 1-1/2 cubic feet and larger, 150 psig working pressure.

C. Construction: Steel outer shell with butyl diaphragm and polypropylene liner.

D. Manufacturer: AMTROL Therm-X-Trol, Bell & Gossett, Armstrong Fluid Technology, or approved.

2.4 DRAIN PANS

A. Description: Galvanized steel sheet metal with raised edge, 16 gage, minimum 4 inch high with all welded joints. Size to accommodate base of water heater. Include 3/4 inch drain outlet connection.

2.5 EXPANSION TANK WALL SUPPORTS

A. Description: Galvanized steel sheet metal with fasteners and stainless steel bands for vertical tanks. HOLDRITE® Thermal Expansion Tank Mounting Bracket or approved.

PART 3 - EXECUTION

3.1 INSPECTION

A. General: Verify installation conditions as satisfactory to receive the Work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

3.2 PREPARATION

A. Field Measurements: Field verify locations of new and existing work prior to commencing the Work of this section.

B. Protection: Protect surrounding areas and surfaces to preclude damage from the Work of this section.

3.3 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

A. General: Install, apply, erect, and perform the Work in accordance with Article “Quality Assurance” provisions, specifications, and manufacturer’s installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

B. Coordinate required electrical and control installation work with Division 26 and Section 230900.

3.4 INSTALLATION OF WATER HEATERS

A. General: Install within sheet metal drain pan.

B. Seismic Restraint: Anchor or strap to wall to resist horizontal displacement due to earthquake motion. Locate straps in accordance with local code requirements.

C. Components: Install as indicated on the Drawings.

D. Electric Water Heaters: Install on an incompressible, insulated pad with a minimum thermal resistance of R-10.

3.5 START-UP SERVICES

A. Equipment manufacturer’s authorized representative shall perform start-up services of water heaters and related appurtenances. Services shall include a check of proper installation, system check-out, adjustment, and complete start-up. Start-up by the Contractor not acceptable.

3.6 PLUMBING SYSTEMS TRAINING

A. Comply with requirements in Section 230810.

B. Representative shall conduct two 2 hour training sessions to demonstrate that equipment operates as indicated in the Contract Documents and in accordance with manufacturer’s recommendations. First session shall cover operation of water heaters. Second session shall cover detailed system operation and trouble shooting. Give minimum one week notice prior to demonstration. Furnish instruments and personnel required to conduct demonstration.

C. Starting time (during any normal operating shift) of training sessions will be determined by the Owner to minimize overtime required for his maintenance personnel.

D. Demonstrate proper performance of operating and safety controls, as well as stable equipment performance over entire operating range to satisfaction of the Owner prior to Substantial Completion.

E. Include instruction session to identify locations of servicing points and required maintenance requirements to the Owner's personnel.

F. Include preliminary discussion and presentation of information from instruction manuals, with appropriate references to the Contract Documents, followed by tour explaining maintenance requirements, access methods, servicing and maintenance procedures, equipment cleaning procedures, control settings and available adjustments.

3.7 COMMISSIONING

A. Equipment and systems referenced in this section shall be commissioned per Section 230800. The Contractor has specific responsibilities for scheduling, coordination, test development, testing and documentation.

END OF SECTION 223000

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Description: The Work includes plumbing fixtures and fittings, installation of and connections to Owner furnished plumbing fixtures and fixtures furnished under other specification divisions and associated appurtenances.

B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions, and Division 01 sections apply to the Work in this section.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.

B. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer. If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.

C. Codes and Standards:

1. Applicable plumbing code pertaining to materials, products, and installation of plumbing fixtures.
2. ASSE 1011, Performance Requirements for Hose Connection Vacuum Breakers.
3. ASSE 1016, Performance Requirements for Automatic Compensating Valves for Individual Showers and Tub/Shower Combinations.
4. ASSE 1019, Performance Requirements for Wall Hydrant with Backflow Protection and Freeze Resistance.
5. ASSE 1052, Performance Requirements for Hose Connection Backflow Preventers.
6. ICC A117.1, Accessible and Usable Buildings and Facilities.
7. NSF 61, Drinking Water System Components-Health Effects.
8. NSF 372, Drinking Water Systems Components – Lead Content.
9. Public Law 102-486, Energy Policy Act.

D. Domestic Water Systems: Products carrying and dispensing water for consumption through drinking and cooking shall be certified by an independent, ANSI-accredited, third party certification organization to requirements of NSF 61 and NSF 372 for 0.25 percent maximum lead content for wetted component base material.

E. Combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

1.3 SUBMITTALS

A. Comply with requirements in Division 01 and Section 230500.

B. Product Data: Submit manufacturer's technical product data and maintenance data for the following. Indicate accessories where required for complete system Verify as to the locations of plumbing fixture accessories such as sink bubbler, glass fillers, ADA compliant shower seats, and similar items with the architectural drawings before submittals are prepared.

1. Plumbing fixtures and trim.
2. Fixture supports.
3. Wall and floor sealant.
4. Blank copy of start-up test and report form.

C. Test Reports:

1. Field start-up and test reports.
2. Submit completed copy of reports and include copy in the Operations and Maintenance Manual.

1.4 DEFINITIONS

A. Accessible Fixture (ADA compliant): Plumbing fixture that can be approached, entered, and used by people with disabilities.

B. Fittings and Trim: Fittings specified in this section include supplies and stops, faucets and spouts, shower heads, drains and tailpieces, and traps and waste pipes.

1.5 COORDINATION

A. Coordinate rough-in and final plumbing fixture locations, and verify that fixtures can be installed to comply with original design and referenced standards.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Water Closets and Urinals: Kohler Co., American Standard, or approved.

B. Lavatories: Kohler Co., American Standard, or approved.

C. Wash Fountains: Intersan, Acorn Engineering Company®, Bradley Corp., Willougby Industries, or approved

D. Stainless Steel Sinks: Just Manufacturing, Elkay Mfg. Co., Kindred, or approved.

E. Service (Mop) Sinks: Zurn, Kohler Co., Acorn Engineering Company®, or approved.

F. Drinking Fountains and Electric Water Coolers: Elkay Mfg. Co., Haws Corporation, Halsey Taylor, Oasis International, or approved.

G. Emergency Fixtures: Haws Corporation, Bradley Corp., Guardian Equipment, Acorn Engineering Company®, Speakman Company, or approved.

H. Hose Bibbs and Wall Hydrants: Acorn Engineering Company®, Chicago Faucets Co., Jay R. Smith Mfg. Co., Wade, Woodford Manufacturing Company, Murdock Manufacturing Inc., or approved.

I. Service Outlets: Guy Gray™, Jones Stephens Corp. (PlumBest), or approved.

J. Faucets for Lavatories, Sinks, and Service (Mop) Sinks: Moen Commercial Div., Chicago Faucets Co., Delta Faucet Co. No substitutions.

K. Miscellaneous Fittings: BrassCraft Mfg. Co., T & S Brass & Bronze Works, McGuire Mfg. Co., or approved.

L. Flush Valves for Water Closets and Urinals: Sloan Valve Company, Zurn Industries, or approved.

M. Closet Seats for Water Closets: Church, Olsonite, Bemis Mfr. Co., Beneke, Kohler Co., or approved.

N. Under-Sink Protection for Accessible Fixtures: Truebro® Lav Guard®, McGuire Mfg. Co. Pro Wrap, or approved meeting ASTM C1822 and ASME A112.18.9.

2.2 PLUMBING FIXTURES AND TRIM, GENERAL

A. Fixture Color: White unless otherwise indicated in the Contract Documents.

B. Exposed Metal Parts: Polished chrome plated finish.

C. Stop Valves: Provide in water connections to fixtures, except where fitting has integral stops. Loose key angle pattern with lock shield, polished chrome plated finish.

D. Exposed Supplies: 1/2 inch outside diameter, polished finish, vertical braided flexible or rigid risers as specified in this section.

E. Pipe Escutcheons: Include where pipe or other fitting enters wall at fixture. Comply with requirements in Section 232116.

F. Tailpiece Extension, Trap, and Arm to Wall: 17 gage, seamless, chrome plated tubing with cleanout for sinks.

G. Vacuum Breaker: Include on water supply to each fixture which has a water connection located below the rim and for fixtures with faucets with threaded outlets for hose attachment, flow-through pattern.

H. Trap Primers: Provide for floor receptors unless trap seals are specified in Section 221300.

I. Under-Sink Protection for Accessible Fixtures:

1. Description: Fully molded flexible vinyl insulation kit for drain piping, P-trap, and hot and cold water supplies under lavatory to meet American with Disabilities Act (ADA) requirements.
2. Rating: UL listed in accordance with ADA.
3. Components: Smooth exterior conforming to pipe and fittings, hidden fastening system, removable trap cleanout cover, and hinged cap at stop valves to allow quick access with snap closure.

2.3 WATER CLOSETS

A. WC-1/WC-2 Water Closet:

1. Description: Kohler Kingston Model K-4325, wall mount, flush valve (top spud), siphon jet, white vitreous china, elongated bowl. Refer to architectural drawings for mounting height.
2. Components:

    a. Flush Valve: Moen Model 8310M128, chrome plated, 1-1/2 inch top spud, 1.28 gallon per flush action, AccuSet piston technology.
    b. Seat: Church Model 9500SSC, self-sustaining check hinge with stainless post, no cover, open front.

2.4 URINALS:

A. UR-1 Urinal:

1. Description: Kohler Dexter Model K-5016-ET-0, wall mount, flush valve (top spud), siphon jet, white vitreous china, extended rim, anti-backsplash wall. Refer to architectural drawings for mounting height.
2. Components:

    a. Flush Valve: Moen Model 8312M0125, chrome plated, 3/4 inch top spud, 0.125 gallon per flush.

2.5 LAVATORIES

A. LV-1 Lavatory (ADA Compliant):

1. Description: American Standard Lucerne Model 0355.012, wall hung, 20 inch by 18 inch, white vitreous china, overflow, back and side splash shields, 4 inch faucet centers, wall hanger. Refer to architectural drawings for mounting height.
2. Components:

    a. Faucet: Moen Commercial Model 8886, deck mounted, adjustable metering type, polished chrome plated solid brass, 4 inch centers, integral 4 inch spout, tapered vandal proof push-tilt handles, 0.5 gpm aerator, 0.25 gallon per cycle, inlet shanks with threaded inlets and coupling nuts.
    b. Drain and Tailpiece: McGuire Model 155A, chrome plated, flat grid strainer, 1-1/4 inch tailpiece.

c. P-trap: McGuire Model 8088, two piece chrome plated, cleanout.
d. Stop Valves: BrassCraft KT Series, loose key, angle stop, quarter turn, chrome plated, wall escutcheon, 12 inch rigid risers.

B. LV-2 Lavatory (ADA Compliant) – Staff:

1. Description: American Standard Lucerne Model 0355.012, wall hung, 20 inch by 18 inch, white vitreous china, overflow, back and side splash shields, 4 inch faucet centers, wall hanger. Refer to architectural drawings for mounting height.
2. Components:

a. Faucet: Moen Commercial Model 8210, deck mounted, manual mixing type, polished chrome plated solid brass, 4 inch centers, integral 5-1/2 inch spout, 2-1/2 inch lever handles, 0.5 gpm aerator, inlet shanks with threaded inlets and coupling nuts.
b. Drain and Tailpiece: McGuire Model 155A, chrome plated, flat grid strainer, 1-1/4 inch tailpiece.
c. P-trap: McGuire Model 8088, two piece chrome plated, cleanout.
d. Stop Valves: BrassCraft KT Series, loose key, angle stop, quarter turn, chrome plated, wall escutcheon, 12 inch rigid risers.

2.6 WASH FOUNTAINS

A. WF-1 4-Station Wash Fountain (ADA Compliant):

1. Description: Sloan Sink System Designer Series 84000, 4 station, wall hung solid surface, continuous trough, heavy duty mounting brackets. Provide with supply manifold and faucets. Refer to architectural drawings for mounting height. Provide with all support brackets and shims to support the system. Provide with grid strainers and P-trap.
2. Components:

a. Faucet: (4) Chicago E80-A11F-41ABCP touch-free, E-cast, adjustable metering type, vandal-proof, single-hole, polished chrome plated solid brass. 1.5 GPM pressure compensating. Provide with power supply at 120V/60 Hz. 3 year warranty on infrared sensor.
b. Thermostatic mixing: Sloan Mix-135-A per faucet
c. P-trap: Provide with washfountain.
d. Stop Valves: BrassCraft KT Series, loose key, angle stop, quarter turn, chrome plated, wall escutcheon, 16 inch flexible risers.

2.7 SINKS

A. SS-1 Band Sink, Single Bowl with Bubbler:

1. Description: Description: Elkay Lustertone Model DLR252110, rectangular, 11 inch front to back by 25 inch wide by 10 inch deep, 18 gage, Type 304 stainless steel, self-rimming, double ledge, off-centered rear drain, U-channel mounting system, polished finish, sound deadened, 8 inch centers.
2. Components:

a. Faucet: Moen Commercial Model 8226, chrome plated, restricted swing spout, deck mounted mixing faucet, ceramic cartridges, Model S0030 5-1/4 inch rigid/swing gooseneck spout 10 inch high, vandal proof aerator, 2-1/2 inch vandal proof lever handles with indexes, 8 inch centers.
b. Drain and Tailpiece: McGuire Model 152, chrome plated, flat grid strainer.
c. P-trap: McGuire Model 8903, 1-1/2 inch tailpiece to 2 inch waste connection, two piece chrome plated, cleanout.
d. Stop Valves: BrassCraft KT Series, loose key, angle stop, quarter turn, chrome plated, wall escutcheon, 16 inch flexible risers. Include separate stop valve for bubbler.
e. Bubbler: Elkay Model LK1141A, chrome plated, push- button operation, self-closing, built-in adjustable volume control. No substitutions.

B. SS-2 Sink (ADA Compliant) – Wall-Hung:

1. Description: American Standard Lucerne Model 0355.012, wall hung, 20 inch by 18 inch, white vitreous china, overflow, back and side splash shields, 4 inch faucet centers, wall hanger. Refer to architectural drawings for mounting height.
2. Components:

a. Faucet: Moen Commercial Model 8210, deck mounted, manual mixing type, polished chrome plated solid brass, 4 inch centers, integral 5-1/2 inch spout, 2-1/2 inch lever handles, 0.5 gpm aerator, inlet shanks with threaded inlets and coupling nuts.
b. Drain and Tailpiece: McGuire Model 155A, chrome plated, flat grid strainer, 1-1/4 inch tailpiece.
c. P-trap: McGuire Model 8088, two piece chrome plated, cleanout.
d. Stop Valves: BrassCraft KT Series, loose key, angle stop, quarter turn, chrome plated, wall escutcheon, 12 inch rigid risers.

2.8 SERVICE (MOP) SINKS

A. MS-1 Service (Mop) Sinks:

1. Description: Zurn Z5850 cast iron custodial floor sink, 28 inch front to back by 28 inch wide by 8 inch deep with 3” drain, dome strainer, removable vinyl-coated rim guard and stainless steel lint basket.
2. Components:

a. Faucet: Chicago Faucets Model 897-CP, with 2 offset inlet supply arms and 2 inlet adapters, wall mounted, manual mixing type with integral stops, polished chrome plated solid brass, 8 inch centers, integral 8 inch spout, pail hook, adjustable wall brace with oval flange, male hose threaded outlet, integral stop valves, and atmospheric vacuum breaker, 2-3/8 inch metal handles, adjustable supply arms, integral drain.
b. Hose and Hose Brackets: Fiat 832-AA, 30 inch long flexible hose.
c. Mop Hanger: Fiat 889-CC, 24 inch by 3 inch.
d. Silicone Sealant: Fiat 833-AA.

2.9 DRINKING FOUNTAINS AND ELECTRIC WATER COOLERS

A. DF-1 Drinking Fountain with Bottle Filler (ADA Compliant):

1. Description: Halsey Taylor HydroBoost Model HTHBWF-OVLSEBP-1, bi-level, in-wall recessed non-chilled drinking fountain with integral no-touch sensor activated bottle filler. Provide with WaterSentry Plus filter with 3000 gallon capacity filter
2. Construction: 18 gauge Type 304 stainless steel construction with ABS plastic alcove for bottle filler, galvanized mounting frame, polished satin finish, waste strainer, fully assembled with front push button, stainless steel back.
3. Stop Valve: BrassCraft KT Series, loose key, straight stop, quarter turn, chrome plated.

2.10 HOSE BIBBS AND WALL HYDRANTS

A. HB-1 Exterior Wall Hydrant, Wallbox:

1. Description: Woodford Model B65, non-freeze wall hydrant, wallbox, brass valve body with hose end, ASSE 1011 anti-siphon vacuum breaker, automatic draining, loose key, wall clamp, 3/4 inch inlet. Stem length to suit wall thickness.

B. HB-2 Interior Hose Bibb, Recessed:

1. Description: Woodford Model B24, recessed box type, chrome brass body with hose end ASSE 1011 anti-siphon vacuum breaker, removable wall flange and door with cylinder lock, loose key wheel handle, 3/4 inch inlet and outlet.

C. HB-3 Exterior Hot and Cold Wall Hydrant, Wallbox:

1. Description: Woodford Model HCB67, non-freeze hot and cold mixing hydrant, wallbox, brass valve body with hose end ASSE 1052 double check valve backflow preventer, automatic draining, loose key, wall clamp, 3/4 inch inlet. Stem length to suit wall thickness.

2.11 FIXTURE SUPPORTS

A. Water Closet Carriers:

1. Concealed cast iron carrier, vertical or horizontal adjustable pattern. Furnish type as required to fit within available wall space. Where wall space is restricted, vertical non-adjustable pattern carriers acceptable.
2. Include support feet set on sub-floor or cast in sub-floor.
3. Include brass fixture attachment bolts with double nuts and chrome-plated acorn type nuts.
4. Include epoxy bolts for bariatric and wall mounted water closets. Lag bolts not acceptable.

B. Wall Hung Fixtures other than Water Closets:

1. Concealed fixture hanger constructed for fixture.

2. Include cast iron feet set on sub-floor, cast in sub-floor, or supported by floor-to-ceiling pipes.
3. Include concealed arm fixture supports where suitable for fixture.

C. Manufacturers: Jay R. Smith, Wade, Josam, Zurn, Watts, or approved.

2.12 WALL AND FLOOR SEALANT

A. Manufacturer and Type: Sanitary type, one-part, mildew resistant silicone sealant. Color to match fixture. General Electric No. 1200 Silicone Building Sealant, Dow Corning No. 780 Construction Sealant, or approved.

PART 3 - EXECUTION

3.1 PRE-INSTALLATION REVIEW

A. General: Verify installation conditions as satisfactory to receive the Work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

B. Before plumbing fixture installation, review in accordance with manufacturer's rough-in instructions for water, soil, and waste piping systems and supports to verify actual locations and sizes of piping connections and that locations and types of supports match those indicated. Use manufacturer's rough-in data.

C. Examine walls, floors, and cabinets for suitable conditions where fixtures will be installed.

3.2 PREPARATION

A. Field Measurements: Field verify locations of new and existing work prior to commencing the Work of this section.

B. Protection: Protect surrounding areas and surfaces to preclude damage from the Work of this section.

3.3 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

A. General: Install, apply, erect, and perform the Work in accordance with Article "Quality Assurance" provisions, specifications, and manufacturer's installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

B. Do not cover up or enclose work until inspected and approved by the AHJ. If in non-compliance, uncover work, remove, and provide new to satisfaction of the A/E at no additional cost to the Owner.

3.4 PLUMBING FIXTURE INSTALLATION

A. Assemble fixtures, trim, fittings, and other components according to manufacturers' written instructions. Refer to architectural drawings for mounting heights.

B. Wall-Hung Fixtures: Install with off-floor supports affixed to building substrate, anchored to allow no movement.

C. Floor-Mounted Fixtures:

1. Install on closet flanges or other attachments to piping or building substrate.
2. Install back-outlet water closets attached to building floor substrate and wall bracket and onto waste fitting seals.

D. Counter-Mounted Fixtures: Install and attach to casework.

E. Install water-supply piping with stop valve on each supply to each fixture to be connected to water distribution piping. Include separate stop valve for fixture accessories such as bubbler and glass filler. Attach supplies to supports or substrate within pipe spaces behind fixtures.

F. For fixtures without integral traps, install trap and waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.

G. Install flush valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.

H. Install toilet seats on water closets.

I. Install instruction sign for dual flush valves in visible location.

J. Install trap-seal liquid in waterless urinals.

K. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

L. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.

M. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

N. Install escutcheons at piping wall and ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with requirements in Section 232116.

O. Seal joints between fixtures and walls, floors, and counters with wall and floor sealant except for bottom of wall hung fixtures**.**

P. Trap Insulation for Accessible Fixtures: Install on exposed drain pipes, traps, tailpieces, waste arm, and on exposed hot and cold water piping stops and supplies. Install per manufacturer's recommendations with fasteners located out of sight for clean appearance.

Q. Install frost proof hydrants 36 inch above finished grade.

3.5 PLUMBING FIXTURES, FITTINGS, AND TRIM CONNECTIONS

A. Piping installation requirements are specified in Sections 221116 and 221300. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect hot and cold water and soil, waste, and vent piping to plumbing fixtures. Comply with equipment manufacturer's installation instructions.

C. Install supplies, stop valves, pressure reducing valves, and similar devices as required between kitchen plumbing fixtures and rough-in plumbing for a complete installation. Obtain kitchen plumbing fixture rough-in drawings prior to installation.

D. Water, Waste, and Vent Connections to Fixtures and Equipment Specified in Other Sections: Connect fixtures and equipment with water supplies, stops, risers, traps, and waste piping specified. Use fittings required to match fixtures and equipment. Connect to plumbing piping.

3.6 FIELD QUALITY CONTROL

A. Verify that installed fixtures are categories and types specified for locations where installed.

B. Check that fixtures are complete with trim, faucets, fittings, and other specified components.

C. Inspect installed fixtures for damage. Replace damaged fixtures and components.

D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

E. Install fresh batteries in sensor-operated mechanisms.

3.7 ADJUSTING

A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

B. Adjust water pressure at faucets and flush valves to produce proper flow and stream.

C. Replace washers and seals of leaking and dripping faucets and stops.

D. Test and balance trap primer systems as specified in Section 221116. Arrange piping to achieve equal flow to each floor receptor.

3.8 CLEANING

A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Perform the following:

1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
2. Remove sediment and debris from drains.
3. Remove labels.

3.9 PLUMBING SYSTEMS TRAINING

A. Comply with requirements in Section 230810.

3.10 COMMISSIONING

A. Equipment and systems referenced in this section shall be commissioned per Section 230800. Contractor has specific responsibilities for scheduling, coordination, test development, testing and documentation.

END OF SECTION 224000

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Description: The Work includes materials, equipment, labor, supervision, tools and items necessary for the construction, installation, connection, testing, and operation of mechanical work. This section applies to all Divisions 21, 22, and 23 sections.

B. General Requirements: General Conditions, Supplementary Conditions, and Division 01 sections apply to the Work in this section.

1.2 CODES AND STANDARDS

A. Perform work in accordance with requirements in the state in which the work is performed.

B. Conform to applicable industry standards, such as UL and ETL standards, ANSI standards, and other standards as noted.

1. Notify the A/E of deviations in the Contract Documents to applicable codes and ordinances prior to installation of the Work. Perform changes in the Work after initial installation due to requirements of code enforcing agencies at no additional cost to the Owner.
2. If conflict occurs between legally adopted codes and the Contract Documents, the codes prevail, except that this shall not be construed as relieving the Contractor from complying with requirements of the Contract Documents which may exceed code requirements and not contrary to same.
3. Arrange for and pay for required permits, fees, and inspections.
4. Pressure Vessels and Relief Valves: Select, build, install, and label in accordance with state requirements and ASME requirements. Frame and mount a certificate showing approval under this law adjacent to each pressure vessel and relief valve. Pay costs and fees for certificates, inspections, filing, and labeling.

1.3 SUBMITTALS

A. Comply with requirements in Division 01 and with additional requirements indicated in this article.

B. Hard Copy Product Data:

1. Comply with requirements in Section 013300 and additional requirements indicated in this article.
2. Submit prior to fabrication of assemblies and delivery of purchased items.
3. Submittal format shall be same as for prime contractor. If general contractor submits hard copies, submit hard copies only. If general contractor submits electronic copies, submit electronic copies with one hard copy.
4. Submit hard copies complete at one time.

5. Partial product submittals not acceptable and will be returned without review except as follows:

    a. Sections 233100, 233300, and 233400 including products and materials for first submittal and the Shop Drawings for second submittal.
    b. Section 230900 including products and materials for first submittal and the Shop Drawings for second submittal.
    c. Sections 230548 and 230550 including products and the Shop Drawings that are contingent upon approval of specified products.
    d. Sections 211000, 212200, and 213000 including products and materials for first submittal and the Shop Drawings for second submittal.
    e. Sections 221116 and 232113 including products and materials for first submittal and the Shop Drawings for second submittal.
    f. Long lead items.
    g. Site and underground work.

6. Clearly mark catalog pages, equipment, and model number to be used. Note required accessories.
7. Identify on cover and spine for each binder with printed title such as “PLUMBING”, “FIRE SUPPRESSION”, or “HVAC” SUBMITTALS, names of Project, Owner, general contractor, subcontractor, architect, and mechanical engineer, and year of project completion.

C. Electronic Product Data:

1. Comply with requirements in Section 013300 and additional requirements indicated in this article.
2. Submit each specification section complete at one time with a dedicated submittal number for each section. For example, submit products for Section 233300 under one submittal number and products for Section 230900 under a different submittal number. Submitting multiple sections at one time acceptable as long as each section has a dedicated submittal number. Include submittal number and date submitted in file name.
3. Partial Product Data submittals for a specification section not acceptable and will be returned without review:

    a. Sections 233100, 233300, and 233400 including products and materials for first submittal and the Shop Drawings for second submittal.
    b. Section 230900 including products and materials for first submittal and the Shop Drawings for second submittal.
    c. Sections 230548 and 230550 including products and the Shop Drawings that are contingent upon approval of specified products.
    d. Sections 211000, 212200, and 213000 including products and materials for first submittal and the Shop Drawings for second submittal.
    e. Sections 221116 and 232113 including products and materials for first submittal and the Shop Drawings for second submittal.
    f. Long lead items.
    g. Site and underground work.

4. Clearly mark catalog pages, equipment, and model number to be used. Indicate associated specification section and paragraph number on each page. Identify required options and accessories.
5. Format:

a. Adobe PDF file format.
b. Bookmark each submittal to facilitate browsing to each specification paragraph number.
c. Include table of contents for each specification section. Include catalog numbers or drawing numbers.
d. Include the Contractor and manufacturer's representative contact information for each product. Include job name (or abbreviation of job name), specification number, and contractor submittal number in file name.

D. Shop Drawings:

1. Submit 3D shop drawings for systems specified in Divisions 21, 22, and 23.
2. Submit prior to starting fabrication and installation work. Do not fabricate or install until reviewed by the A/E. Include complete location dimensions, hanger and support sizes and dimensions.
3. Complete drawings in timely manner and coordinate with construction schedule.
4. "Typical" drawings and wiring diagrams not acceptable unless they specifically apply to this project.
5. Show required coordination with work of other trades including electrical conduits, cable trays, structure, lighting fixtures and other items to be installed in ceilings, full height walls, and other items necessary to coordinate installation.
6. Floor plan backgrounds are available in electronic format and shall be requested from the A/E.
7. Direct use of the Drawings as the basis of the Contractor's prepared Shop Drawings not acceptable.
8. HVAC, controls, plumbing, and fire protection subcontractors shall include in their bids attendance at coordination meetings on site to coordinate their work utilizing visual representation of 3D model.
9. Format:

    a. 3D drawings using industry recognized software for systems and areas of the building.
    b. Minimum scale 1/4 inch per foot on same size sheets as the Drawings.
    c. Adobe PDF file format.

10. Content:

    a. Fire Protection: Complete fire suppression installation consisting of detailed fire suppression drawings. Comply with requirements in 211000.
    b. Plumbing: Complete plumbing installation consisting of detailed piping drawings. Show piping, valves, thermal expansion loops, equipment, hangers, seismic bracing, vibration isolation, and other HVAC components included in the Contract Documents. Indicate sizes of piping, installed piping bottom of piping (BOP) above finished floor, equipment dimensions, dimensioned location of equipment and height above finished floor, slope of piping where applicable, and equipment tags.
    c. Airside HVAC: Complete duct installation consisting of detailed sheet metal drawings. Show ducts, duct fittings, turning vanes, air devices, flexible ducts, volume dampers, motorized dampers, backdraft dampers, hangers, supports, seismic bracing, vibration isolators, equipment and other HVAC components included in the Contract Documents. Indicate sizes of ductwork, installed ductwork bottom of duct (BOD) above finished floor, equipment dimensions, dimensioned location of equipment and height above finished floor, air device tags indicating same information included on the Drawings, and equipment tags.

d. Wetside HVAC: Complete pipe installation consisting of detailed piping drawings. Show piping, valves, thermal expansion loops, equipment, hangers, seismic bracing, vibration isolation, and other HVAC components included in the Contract Documents. Indicate sizes of piping, installed piping bottom of piping (BOP) above finished floor, equipment dimensions, dimensioned location of equipment and height above finished floor, slope of piping where applicable, and equipment tags.
e. HVAC controls: Complete controls installation consisting of detailed controls drawings. Comply with requirements in Section 230900.

E. Approval: Approval of manufacturer's name or Product by the A/E does not relieve the Contractor of responsibility for providing materials and equipment which comply in detail with requirements of the Contract Documents.

F. Re-Submittals: Clearly identify re-submittals. Provide revised tabs, indexes, page renumbering, and other formats to interface with original submittal. Identify changes and include date for project tracking.

G. Test Reports and Certificates: Submit as package prior to Substantial Completion.

H. Testing and Balancing Reports: Submit as indicated in Section 230593.

I. Certifications: Submit written certifications from governing building authorities stating that the Work has been inspected and accepted, and complies with applicable codes and ordinances.

J. Record Drawings: Comply with Article "Record Drawings" in this section.

K. Commissioning: Submit equipment start-up and test procedures and preliminary Operations and Maintenance Manuals to the A/E as specified in Section 230820. Submit under separate bound cover.

1.4 SCHEDULE OF VALUES

A. Comply with requirements in Division 01 with additional requirements as indicated in this article.

B. Include labor and material costs as follows:

1. Permit, Mobilization, Submittals, and Bond.
2. Trailer, Services, Cranes, and Rentals.
3. Foreman/Non-Labor.
4. Fuel Costs.
5. Project Closeout and System Startup.
6. Punchlist.
7. Record Drawings.
8. Basic Materials and Methods.
9. Electrical Provisions.
10. Mechanical Demolition.
11. Electrical Heat Trace, Labor.
12. Electrical Heat Trace, Material.
13. Mechanical Systems Commissioning.
14. Systems Training.
15. Systems Operations and Maintenance Manuals.

16. Fire Suppression Engineering and Shop Drawings.
17. Wet Pipe System, Labor.
18. Wet Pipe System, Material.
19. Dry Pipe System, Labor.
20. Dry Pipe System, Material.
21. Testing, Adjusting, and Balancing.
22. Mechanical Insulation, Labor.
23. Mechanical Insulation, Material.
24. Domestic Water, Labor.
25. Domestic Water, Material.
26. Plumbing Valves, Labor.
27. Plumbing Valves, Material.
28. Plumbing Pumps Labor.
29. Plumbing Pumps, Material.
30. Soil, Waste, Vent, and Storm Drain Piping Systems, Labor.
31. Soil, Waste, Vent, and Storm Drain Piping Systems, Material.
32. Plumbing Equipment, Labor.
33. Plumbing Equipment, Material.
34. Plumbing Fixtures, Labor.
35. Plumbing Fixtures, Material.
36. Indoor Air Quality.
37. Piping Specialties, Labor.
38. Piping Specialties, Material.
39. Automatic Temperature Controls (ATC), Labor.
40. Automatic Temperature Controls (ATC), Material.
41. ATC Engineering and Shop Drawings.
42. ATC, Commissioning.
43. ATC, Owner Training.
44. Variable Frequency Drives, Labor.
45. Variable Frequency Drives, Material.
46. Hydronic Piping, Labor.
47. Hydronic Piping, Material.
48. Underground Piping, Labor.
49. Underground Piping, Material.
50. Water Treatment Systems, Labor.
51. Water Treatment Systems, Material.
52. Air Distribution, Labor.
53. Air Distribution, Material.
54. Air Distribution Accessories, Labor.
55. Air Distribution Accessories, Material.
56. Air Distribution Equipment, Labor.
57. Air Distribution Equipment, Material.
58. Air Devices, Labor.
59. Air Devices, Material.
60. Filters, Labor.
61. Filters, Material.
62. Air Cooled Chillers, Labor.
63. Air Cooled Chillers, Material.
64. Packaged HVAC Equipment, Labor
65. Packaged HVAC Equipment, Material.

1.5 DEFINITIONS AND ABBREVIATIONS

A. Refer to Division 01 sections for definitions and abbreviations. Additional definitions and abbreviations are as follows.

B. “Approved” or “Approval” means written approval by the Owner or “Owner’s agent” (A/E).

C. “Codes” means the AHJ adopted codes, rules, and ordinances and additional codes as specified herein.

D. “Concealed and Concealed Work” means Work installed in spaces out of sight. For example, above ceilings, below floors, between double walls, within furred-in areas, within pipe and duct shafts, behind cabinets, and similar locations and spaces not exposed to view.

E. The word “Contractor”, as used in Divisions 21, 22, and 23 sections, means fire suppression, plumbing, or HVAC subcontractor.

F. “Coordination”, “Coordinating”, and “Coordinate” mean to bring, or bringing, into common action, movement, or combination so as to act together in smooth concerted way.

G. “Directed”, “Requested”, “Accepted”, and similar terms mean these terms imply “by the A/E” unless otherwise indicated.

H. “Exposed” means open to view of occupants in normally occupied areas. Work installed in mechanical, electrical, and equipment rooms is defined as exposed. Likewise for Work installed within accessible air distribution plenums, pipes installed in tunnels, and pipes installed in a room not covered by other construction.

I. “Furnish” means supply and deliver to Project site ready for unloading, unpacking, assembly, installation, and similar activities.

J. “Indicated” and “Indicated on the Drawings” means shown on the Drawings by notes, graphics or schedules, or written into other portions of the Contract Documents. Terms such as “shown”, “noted”, “scheduled” and “specified” have same meaning as “indicated”, and are used to assist reader in locating particular information.

K. “Install” means to place in position for service or use. Includes operations at Project site, such as unloading, unpacking, assembly, erection, placing, preserving, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar activities.

L. “Mechanical Rooms” mean such spaces as mechanical rooms, accessible mechanical attics, mechanical mezzanines, boiler rooms, and other type of rooms and spaces that house mechanical and plumbing equipment. This definition applies to multiple specification sections and as noted as room names on the Drawings.

M. “Provide” means furnish and install for complete, finished, and operable system and ready for intended use.

N. “Shop Drawings” means documents which fully detail equipment and intended installation relative to this specific Project.

O. "Substantial Completion" shall mean that entire project (or readily definable portion thereof if so designated in the Contract Documents) is acceptable to code enforcement authorities and to extent required by such authorities, has been inspected and approved by such authorities, and is suitable for occupancy by the Owner or occupant for purpose intended. Refer to Divisions 00 and 01 sections for additional requirements.

P. "Work" or "Project" means entire scope of work required by the Contract Documents.

Q. Abbreviations:

A/E	Architect /Engineer
AHJ	Authorities Having Jurisdiction
AMCA	Air Movement and Control Association
ANSI	American National Standards Institute
ARI	Air Conditioning and Refrigeration Institute
ASHRAE	American Society of Heating, Refrigerating & Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWS	American Welding Society
C	Degrees Celsius
CISPI	Cast Iron Soil Pipe Institute
CSA	Canadian Standards Association
ETL	Environmental Technology Laboratory
F	Degrees Fahrenheit
FM	Factory Mutual
FOIC	Furnished by Owner Installed by Contractor
HVAC	Heating, Ventilating, and Air Conditioning
IAPMO	International Association of Plumbing and Mechanical Officials
IBC	International Building Code
IFC	International Fire Code
IFGC	International Fuel Gas Code
IMC	International Mechanical Code
IPC	International Plumbing Code
LEED	Leadership in Energy and Environmental Design
MERV	Minimum Efficiency Reporting Value
MSS	Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.
NEC	National Electrical Code, NFPA 70 (latest adopted edition with Amendments)
NEMA	National Electrical Manufacturer's Association
NFPA	National Fire Protection Association
NSPC	National Standard Plumbing Code
OSHA	Occupational Safety and Health Administration
PSI	Pounds per square inch
PSIG	Pounds per square inch gage pressure
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association, Inc.
UL	Underwriters Laboratories Inc.
UPC	Uniform Plumbing Code
V	Volts
WOG	Water Oil Gas
WSP	Working Steam Pressure

1.6 MATERIALS

A. Where two or more manufacturers are listed, select for use any of those listed. The first mentioned, in general, was used as basis of design. Bids on any manufacturer named acceptable as long as that manufacturer meets every aspect of the Contract Documents. Where several manufacturers are specified by name for one use, select for use any of those specified. Note that equipment layout is based on equipment listed in equipment schedules.

B. Ensure that equipment will fit within available space. Where other than basis of design manufacturer is selected for the Project, the Contractor is responsible for verifying equipment will fit within available space and meet manufacturer's and code required clearances.

C. Where other than basis of design manufacturer is selected for the Project, include cost of resulting additional work, coordination with other trades, and redesign of associated building services and structure as required to accommodate selected equipment. Include redesign drawings with submitted Shop Drawings.

D. Should any proposed Product require redesign work by the A/E to accommodate proposed Product, costs for such redesign work shall be included in the Bid amount. The Owner will compensate Engineer through the A/E at rate of $150.00 per hour for time and expense for required review of submittals and additional coordination for redesign work. Amount of compensation will be deducted from Final Payment to the Contractor.

1.7 STANDARDS OF QUALITY

A. Equipment shall be manufacturer's regularly catalogued items and shall be supplied as complete unit in accordance with manufacturer's standard specifications and any optional items required for proper installation for equipment unless otherwise noted. Install equipment and materials in accordance with manufacturer's recommendations and best trade practices.

B. Furnish products of single manufacturer for items which are used in quantity. A Product, for purpose of this paragraph, is assembly of components such as fans, air handling units, chillers, valves, and similar items. Materials such as pipe, fittings, pipe and duct insulation, and similar items not requiring maintenance are not included in single manufacturer requirement of this paragraph.

C. Products shall be new unless indicated otherwise in the Contract Documents.

1.8 SUBSTITUTIONS

A. Comply with requirements in Division 01 with additional requirements indicated in this article.

B. Substitutions will be considered following bid award only when a product becomes unavailable through no fault of the Contractor.

C. Where "manufacturer" paragraphs include the words "or approved", prior approval of the proposed substitution is required. The A/E is sole judge of quality of proposed substitution.

D. When the A/E approves a substitution request, approval is given with understanding that the Bidder:

1. Has investigated proposed Product and determined that it meets or exceeds quality level of specified Product.
2. Will provide same warranty for substitution as for specified Product.
3. Will coordinate installation and make changes to other Work which may be required for the Work to be complete with no additional cost to the Owner.
4. Waives claims for additional costs or time extension which may subsequently become apparent.

E. Whenever a Product is described by detail, specification, trade name, manufacturer's name or catalog reference, use only such Product, unless written approval is given for substitution prior to bid. Submit written requests on substitution request form included in Division 01. Approved substituted manufacturers will be listed by Addendum.

F. Provide as specified certain products, materials, and systems where "manufacturer" paragraphs are followed by the words "No substitutions".

G. Substitutions will not be considered when they are indicated or implied on the Shop Drawings or product data submittals, without separate written prior approval, or when approval will require revision to the Contract Documents.

1.9 DRAWINGS AND SPECIFICATIONS

A. General: Mechanical drawings are diagrammatic. Complete details of building features which affect fire suppression, plumbing, and HVAC installations may not be shown. For additional details, refer to other Contract Documents. Report any discrepancies to the A/E along with suggested revisions. Obtain written response from the A/E before proceeding with changes.

B. Depiction of the Work: The Drawings do not show exact characteristics of the Work, piping and air distributions configurations, or necessary number of fittings and offsets. Base work on actual field measurements and conditions. Provide work required to complete installation.

C. Dimensions: Do not scale drawings. Dimensional accuracy is not guaranteed, and field verification of dimensions, locations, and levels to suit field conditions is required.

D. Discrepancies: Field verify dimensions and existing conditions prior to performing the Work. Bring to the A/E's attention any discrepancies within the Contract Documents and between the Contract Documents and field conditions. Also for any design and layout changes required due to specific equipment selection, prior to the Contractor's work (equipment and material purchasing and installation). Any corrective work required by the Contractor after his discovery of such discrepancies, inconsistencies, or ambiguities shall be performed at no additional cost to the Owner.

E. Specifications: These specifications are written in imperative mood and streamlined form. Imperative language is directed to the Contractor, unless specifically noted otherwise. The words "shall be" are included by inference where a colon (:) is used within sentences or phrases.

1.10 RECORD DRAWINGS

A. Comply with requirements in Division 01, with additional requirements indicated in this article.

B. Prepare Record Drawings. Record Drawings shall be new black line prints (pencil and black pen not acceptable) and shall show measured locations of portions of the Work and changes the Contractor has made.

C. Record corrections and changes made during progress of the Work, showing work as actually installed. In general, acceptable tolerance plus or minus 1'-0" from actual location in horizontal plane. Indicate exact installed invert elevations for underground piping. Neatly hand-draft on daily basis. Keep readily available at project site. Use latest revisions and keep neat and clean. Do not use the Contractor's working drawings.

D. Record Drawings are subject to review by the A/E on regular basis throughout construction. At end of construction, check drawings for completeness and accuracy.

E. Drawings shall show addendum items, change orders, clarifications, supplemental instructions, and deviations from the Drawings.

F. Per project closeout procedures, submit in AutoCAD format along with corrected black line drawings. Each sheet shall be noted as "RECORD DRAWING".

1.11 COORDINATION

A. Coordinate Divisions 21, 22, and 23 Work with other trades.

B. Be aware of restricted space for installation of fire suppression, plumbing, and HVAC systems. Include offsets and perform rerouting and coordination to fit elements in available space. Include provisions for such requirements in bid.

C. Equipment, ductwork, and piping shown are based on existing drawings as available and on limited project site observations to extent possible under current conditions. Field verify existing conditions prior to commencement of Work. Obtain specific locations of structural and architectural features or equipment items from referenced drawings, field measurements, or trade providing material or equipment.

D. Coordinate ductwork and piping installations to clear light fixtures and electrical cable trays. Include clearance over light fixtures to allow removal and replacement. Include minimum 6 inch clearance above and to sides of cable trays. Coordinate routing of ductwork and piping with each other and other trades so grade of piping can be accomplished and fit in available space.

E. Coordinate clearance requirements with piping installation for piping insulation applications, duct installation for duct insulation applications, and equipment installation for equipment insulation applications. Before preparing piping and duct Shop Drawings, establish and maintain clearance requirements for insulation applications and field-installed insulation jackets and finishes and for space required for maintenance.

F. Ductwork takes precedence over piping for available space and routing. Coordinate installation based on this precedence.

G. Do not install ductwork and piping over electrical panels and where clearance is required by code and for maintenance.

H. Existing Conditions:

1. General Construction:

   a. Installation of fire suppression, plumbing, and HVAC work will require openings, removal and replacement of ceilings, sleeves, and restoration of general construction to match existing. Some work occurs in areas not requiring alterations as part of architectural work. Coordinate new openings and restoration work so that there is no additional cost to the Owner.
   b. General construction work shown on architectural drawings may require removal, relocation, and reinstallation of existing fire suppression, plumbing, and HVAC work. Since existing conditions cannot be completely detailed on the Drawings, survey site and perform required Work at no additional cost to the Owner.

2. Piping: Verify exact location, flow direction and service before making connections to such piping. Remove and provide new piping where existing piping is damaged or broken during construction.
3. This project may require work in presence of asbestos containing material (ACM). Division 23 does not provide for or cover identification, removal, encapsulation, or disposal of such material. If presence of ACM is suspected, notify the Owner prior to proceeding in vicinity of ACM.

I. Be responsible for beam penetrations as they relate to fire suppression, plumbing, and HVAC work. Submit sizes and locations to structural engineer for review and determination of structural details.

J. Coordinate attachments to structure to verify that attachment points on equipment and structure can accept seismic, weight, and other loads imposed.

K. Refer to architectural and structural drawings for location of expansion and seismic joints. Provide flexible loops for piping and flexible connectors for ducts crossing expansion and seismic joints.

1.12 WORKMANSHIP

A. Work shall be in accordance with best trade practices. Remove substandard workmanship and provide new material at no additional cost to the Owner.

1.13 HVAC SYSTEM USAGE

A. The Contractor’s use of permanent HVAC systems for temporary heat and ventilation prior to requirements of Section 230512 is not allowed.

1.14 SITE VISIT

A. The Contractor shall visit site during bidding period to note conditions affecting installation of the Work. No additional charges allowed due to failure to adequately review conditions.

B. Investigate each space through which equipment must be moved. Where necessary, arrange with equipment manufacturers to ship equipment in sections with suitable dimensions for moving through restricted spaces. For movement through occupied spaces, ascertain from the Owner as acceptable times of day or night that movement could occur. Include costs in the Bid for off hours labor, reassembly, and field testing.

1.15 CERTIFICATION

A. By submitting a Bid for fire suppression, plumbing, and HVAC systems, the Contractor and his subcontractors acknowledge and certify the following:

1. That they have carefully examined and fully understand the Drawings and Specifications including but not limited to architectural, site, utility, mechanical, structural, and electrical drawings, and their specifications. In addition, they have determined that the Drawings and Specifications are adequate to complete fire suppression, plumbing, and HVAC systems and that they can provide complete finished and operable system in accordance with the Contract Documents.
2. That they have had reasonable opportunity to discover any ambiguities in the Contract Documents and such ambiguities have been brought to attention of the A/E in writing prior to submitting the Bid.
3. That they have reviewed project progress schedule with general contractor, fully understand schedule, and they have verified, prior to submitting a Bid, availability of necessary labor and materials, including supervision and office backup, and can comply with schedule requirements.
4. That there may be changes to scope of work and that they understand that any proposal submitted for performance of additional work shall include costs associated with such change including but not limited to labor, materials, subcontracts, equipment, taxes, fees, schedule impact, loss of efficiency, supervision, overhead, and profit.
5. That the Contract requires them to coordinate their work with that of other trades and that responsibility for coordination includes rerouting, offsets, and similar provisions, to fit the Work and address manufacturer’s recommended clearances for service access, maintenance, and replacement of equipment in manner that is compatible with the Work of other trades in same area.
6. That routing of elements of fire suppression, plumbing, and HVAC systems shown on the Drawings is schematic only and that offsets and rerouting will be required in installation and that labor and materials for offsets and rerouting have been included for such in their bids.
7. That they have consulted with affected utilities and included in their bids labor and materials to meet requirements which may be imposed by each utility and have included in their bids costs and fees to be paid to such utilities, including temporary services and temporary and permanent connections unless specifically excluded in the Contract Documents.
8. That they understand submittals of material and equipment to the A/E is for the purpose of establishing what they are providing for the Project. Any review undertaken by the A/E does not relieve them of their responsibilities to furnish and install materials and equipment required for the Work in the Project nor does such review relieve them of their responsibilities for coordination with other trades and designers to ensure that such materials and equipment will fit and be suitable for purpose intended.
9. That they agree to receive payment for bid amounts as full compensation for furnishing materials and labor which may be required in prosecution and completion of the Work required under the Contract Documents, and in respects to complete the contract work to satisfaction of the A/E.

10. That they include in their bids costs to furnish bonds as specified in the Contract Documents.

1.16 WARRANTY

A. Conform to requirements in General Conditions, Supplementary Conditions, and Division 01. Where not so prescribed or defined, the period shall be 1 year. Warranty periods within Divisions 21, 22, and 23 shall not commence until Substantial Completion date. Contractor shall extend longer warranties specified in other sections.

1.17 EQUIPMENT FURNISHED BY OWNER INSTALLED BY CONTRACTOR (FOIC)

A. Material Handling and Delivery: Coordinate delivery of FOIC equipment. Receive, off load, transport, store, hoist, unpack, dispose of packing, same as for other project equipment arriving at job site. Requirements of the Contract Documents apply to FOIC equipment.

B. Operations and Maintenance Data: Obtain from the Owner operations and maintenance data for FOIC equipment and incorporate them into the Operations and Maintenance Manuals.

C. Start-up and Warranty:

1. FOIC equipment suppliers will pass on to the Contractor start-up information, maintenance and parts information, and warranty provisions of their products in accordance with the equipment suppliers contract requirements. Organize and coordinate start-up and warranty requirements for FOIC equipment.
2. Include one year warranty on FOIC equipment starting at Substantial Completion regardless of shorter time limits by FOIC suppliers.

1.18 DEMONSTRATION

A. Comply with requirements in Division 01 with additional requirements indicated in this article.

B. Following installation of fire suppression, plumbing, and HVAC work and prior to final acceptance, demonstrate that equipment and systems operate as indicated in the Contract Documents and in accordance with manufacturer’s recommendations.

C. Perform in presence of the A/E and the Owner’s representative, unless otherwise directed by the A/E. Give minimum 1 week notice prior to demonstrations.

D. Provide instruments and personnel required to conduct demonstrations.

1.19 SUBSTANTIAL COMPLETION

A. Comply with requirements in Divisions 00 and 01.

B. Prepare list of items that are not complete prior to asking for the Substantial Completion review by the A/E.

C. Review of the Work: The A/E's fee for mechanical work includes 2 final construction observation reviews. First one is the Substantial Completion review of the Work and will be in response to the Contractor's notice of final completion of the Work. If necessary, second one is post-Substantial Completion review of the Work and will occur after notification by the Contractor that deficiencies noted during the Substantial Completion review have been corrected.

D. Cost of Additional Reviews: If additional reviews by the A/E are required due to Contractor's failure to correct deficient work, the Owner will compensate the A/E on a time and expense basis at rate of $150.00 per hour. Amount of additional compensation for additional reviews will be deducted from the Final Payment to the Contractor.

1.20 ALTERNATES

A. General: See Bid Form and Alternates described in Division 01 for possible effect on work of Divisions 21, 22, and 23.

1.21 CONTINUITY OF EXISTING UTILITY SERVICES

A. Shutdown Duration: Comply with requirements in Division 01. Perform work without shutdown of more than 4 hour duration of existing systems when the school is scheduled for occupancy. Schedule each shutdown in writing with the Owner at least 7 days in advance of shutdown and obtain advance written approval from the Owner.

B. Temporary Services: Provide during necessary interruptions of existing utilities.

C. Owner Occupancy:

1. Perform the Work in existing building with respect for necessity of the Owner's employees to perform their regular work.
2. Plan installation of new work and connections to existing work to assure minimum interference with regular operation of existing facilities. Do not remove, disconnect, or shutdown systems without prior review by the Owner to confirm that areas needed to remain in operation are not affected.
3. Provide temporary piping, ductwork, wiring, controls, and similar systems and connect to existing systems to keep existing fire suppression, plumbing, and HVAC systems in operation to service areas that need to remain occupied.

1.22 COMMISSIONING

A. Comply with requirements in Sections 019113 and 230800.

B. Equipment manufacturer's authorized representatives shall perform start-up and testing services as specified in Sections 019113 and 230800.

C. Submit equipment start-up and test procedures and preliminary Operations and Maintenance Manuals to the A/E as specified in Section 230820. Submit under separate bound cover.

1.23 WASHINGTON SUSTAINABLE SCHOOLS PROTOCOL (WSSP)

A. General: The Owner has established environmental and high performance goals for this project through the WSSP High Performance School Rating System dated October 20, 2010. The Contractor is responsible for conformance with credits being pursued in the Protocol as specified in Division 01. Strict adherence to the Contract Documents and critical path schedule is required to meet WSSP requirements.

B. The Contractor acknowledges that as condition of bidding this Project, every reasonable effort will be made to perform the Work in such a manner as to enable identified WSSP goals to be achieved. To this end, the Contractor's responsibilities shall include, but are not limited, to the following:

1. Compliance with requirements of the Contract Documents, including submittal of required documentation to verify conformance with WSSP credits pursued.
2. Assisting the Owner and the A/E with documentation for final WSSP self-evaluation.

C. Health, safety, performance, and durability shall take precedence over sustainable design criteria. The Contractor shall inform the Owner and the A/E of conflicts that may result between specified requirements and sustainable materials.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

Not used.

END OF SECTION 230500

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Description: The Work includes material and labor required to perform start-up of equipment and systems installed in project, to perform checkout of systems, and to verify completeness of project requirements.

B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 and Sections 230500, 230510, and 230593 apply to the Work in this section.

C. Refer to requirements in Sections 230800 and 230512.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.

1.3 SUBMITTALS

A. Comply with requirements in Division 01 and Section 230500.

B. Submit within 4 weeks of award of Contract the following for review and approval by the A/E and Commissioning Authority.

1. Checklist for each piece of scheduled equipment indicating items that will be verified for proper operation and completeness of installation. Include an area for comments and completion date for correction of deficiencies. Use of the equipment manufacturer's standard start-up/checkout form is acceptable.
2. Checklist of controls by system or piece of equipment indicating items that will be checked, sequences that will be checked, and completeness of the installation. Include an area for comments and completion date for correction of deficiencies.
3. Checklists shall have a place at each item for the person doing checkout to initial item indicating task has been completed and date it was completed.
4. Preliminary schedule indicating sequence of events involved with pre-functional check-out, equipment start-up, testing and balancing (TAB), TAB verification, and functional testing. Schedule shall indicate approximate time intervals required for completion of respective tasks.
5. Prepare and submit a list of items that are not complete prior to requesting substantial completion review by the A/E.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

3.1 PROJECT CLOSEOUT PROCEDURES

A. Complete the Work described in this section prior to time of Substantial Completion.

B. Use pre-functional checklists prepared by Commissioning Authority to verify completeness of system installation and proper system operation. Submit completed checklists for review prior to Substantial Completion.

C. Schedule pre-startup coordination meeting with the Architect, the Owner, the Engineer and the Commissioning Authority for the specific purpose of achieving a coordinated systems start-up.

D. Representatives for the mechanical subcontractor, plumbing subcontractor, sheet metal subcontractor, temperature control subcontractor and TAB subcontractor shall be present at the pre-startup meeting and at the initial startup of each mechanical system.

E. Mechanical subcontractor shall bear prime responsibility for startup of heating and cooling and plumbing systems.

F. If a piece of equipment is not performing satisfactorily during TAB, TAB subcontractor shall notify the installing subcontractor for corrective action.

G. All subcontractors shall comply with the decision of the Construction Manager and the A/E of any conflict of responsibility.

H. Include completed checklists in the Operation and Maintenance Manuals.

3.2 SYSTEM START-UP PROCEDURES

A. As a minimum, the items listed in this article shall be completed. Include recommendations by manufacturers of systems and equipment.

B. Inspect bearings for cleanliness and alignment and remove foreign materials found. Grease in accordance with manufacturer's recommendations. Replace bearings that run rough or noisy.

C. Adjust tension in V-belt drives, adjust variable-pitch sheaves and drives for required equipment speed. Change belts and sheaves to obtain proper equipment speed, remove any foreign materials from sheaves and belts before starting operations, adjust drives for alignment of sheaves and V-belts. "Required equipment speed" is that speed which produces intended performance. Adjust fans and rotating equipment to maintain operation within the performance curve provided by manufacturer without over speeding equipment or causing excess vibration.

D. Adjust direct drives for proper alignment of flexible couplings, lubricate particular couplings, check security of couplings to driver and driven shafts, and set drive components to ensure free rotation with no undesirable stresses on coupling and attached equipment.

E. Check pump packing glands and mechanical seals for cleanliness and adjustment before running pump. Inspect shaft sleeves for scoring and proper placement of packing, replace if

necessary. Inspect mechanical faces, chambers and seal rings. Replace if necessary. Ensure piping systems are free of dirt and scale before circulating liquid through pumps.

F. Tighten flanges and packing glands after systems have been placed in operation. Replace gaskets in flanges that show signs of leakage after tightening.

G. Inspect both manual and automatic control valves, clean bonnets and stems, tighten packing glands to ensure no leakage, but permit valve stems to operate properly. If leaking, replace packing in valves to retain maximum adjustment after system is judged complete. Replace packing in any valve that continues to leak after adjustment, remove and repair bonnets that leak, coat packing gland threads and valve stems with surface preparation similar to MolyCote or FelPro after cleaning.

H. Inspect and make certain that automatic control valve seats are free from foreign material and are properly positioned for intended service.

I. Inspect screwed joints for leakage and remake each joint that appears to be faulty. Do not wait for rust to form. Clean threads on both parts, apply compound and remake joint.

J. Clean strainers, dirt pockets, orifices, valve seats and headers in fluid systems after systems have been placed in operation to ensure they are free from foreign materials.

K. Adjust pipe hangers and supports for correct pitch and alignment.

L. Remove rust, scale and foreign materials from equipment and renew any defaced surfaces. If equipment is badly marred, the A/E has authority to require new materials be provided.

M. Install clean air filters. Refer to requirements in Section 234100.

N. Inspect pressure gages and thermometers for calibration. Remove and provide new for those that are defaced, broken, or read incorrectly.

O. Repair damaged insulation.

P. After each system has been put into operation, repeat certain checks described in preceding paragraphs.

Q. Complete applicable start-up procedures described in preceding articles and paragraphs prior to Substantial Completion.

R. Provide adjustment services as necessary to ensure proper functioning of systems after building occupancy and during warranty period.

3.3 SCHEDULE OF VALUES

A. Include a line item in schedule of values for doing the project closeout and system start-up work. Value shall include the time for preparing initial checklists, for checking out project, and for starting up systems. Value shall accurately reflect amount of time and material Contractor estimates to spend on these tasks.

3.4 FINAL ACCEPTANCE

A. Final acceptance of the Work will not occur until functional testing is complete and outstanding issues resolved.

END OF SECTION 230505

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Description: The Work includes equipment supports, sleeves, identification, appurtenances, and miscellaneous work. This section applies to all Divisions 21, 22, and 23 sections.

B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to the Work in this section.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.

B. UL Compliance: Where UL fire-resistance rating is indicated for construction penetrated by access units, furnish UL listed and labeled units, except for those units which are smaller than minimum size requiring ratings as recognized by governing authority.

C. Codes and Standards:

1. ASME A13.1, Scheme for the Identification of Piping Systems for lettering size, colors and installed viewing angles of identification devices unless other requirements are specified.
2. ASTM D 709, Standard Specifications for Laminated Thermosetting Materials.
3. ASTM D 1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3).
4. ASTM D 2321, Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
5. ASTM E 84, Standard Test Method for Surface Burning Characteristics of Building Materials.
6. ASTM E 814, Standard Test Method for Fire Tests of Penetration Firestop Systems.
7. NFPA 255, Surface Burning Characteristics Building Materials.
8. UL 723, Standard for Test for Surface Burning Characteristics of Building Materials.
9. UL 1479, Standard for Fire Tests of Through-Penetration Firestops.

1.3 SUBMITTALS

A. Comply with requirements in Division 01 and Section 230500.

B. Product Data: Submit manufacturer’s technical product data and maintenance data for the following:

1. Equipment supports
2. Sleeves
3. Pipe markers and color bands
4. Underground pipe markers

5. Equipment nameplates
6. Valve tags
7. Ceiling access doors
8. Roof penetrations

C. Valve schedule for each piping system.

D. Valve location drawings.

E. Test Reports: As required in specific specification sections.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products in accordance with manufacturer's recommendations, using means and methods to prevent damage, deterioration, and loss, including theft.

B. Deliver products to site in manufacturer's original containers, complete with labels.

C. Inspect products upon delivery to ensure compliance with the Contract Documents and to ensure that products are undamaged and properly protected.

D. Store products subject to damage by weather conditions above ground, under cover in weathertight enclosure, with ventilation adequate to prevent condensation. Maintain temperature and humidity within range required by manufacturer's instructions.

E. Close open ends of equipment and work with temporary covers or plugs during storage and construction to prevent entry of foreign material.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials shall be new and of manufacturers specified herein. They shall be U.S. made and bear the UL, ETL or CSA labels where possible.

2.2 EQUIPMENT SUPPORTS

A. Select and size supports, expansion shells and bolts, concrete inserts, and anchor bolts per requirements for seismic restraints specified in Section 230550. Hot dipped or mechanically galvanized where installed outdoors unless noted otherwise on the Drawings. Damaged galvanized surfaces repaired with ZRC Worldwide Galvilite® Galvanizing Repair.

B. Expansion Shells and Bolts and Concrete Screws:

1. Manufacturers for Expansion Shells for Rod Hangers: Simpson Strong-Tie®, Hilti, or approved for holes drilled in concrete.
2. Manufacturers for Expansion Bolts for Equipment: Simpson Strong-Tie®, Hilti, or approved for holes drilled in concrete.

3. Manufacturers for Concrete Screws for Equipment: Simpson Strong-Tie®, Hilti, or approved for holes drilled in concrete.

C. Concrete Inserts: Comply with requirements in Section 232116.

D. Formed Steel Channels: Twelve gage minimum, 1-5/8 inch by 1-5/8 inch minimum cross-section size, epoxy coated. Cooper B-Line Dura-Green™ or Dura-Copper™, Unistrut, POWER-STRUT®, or approved.

E. Rooftop Equipment Supports: Prefabricated, 18 gage galvanized steel, unitized construction, galvanized cap flashing, internal reinforcement, continuous welded corner seams, minimum 9-1/2 inch overall height. Top of support level where installed on sloped roofs. Roof Products & Systems Style ER-4A or approved.

F. Anchor Bolts: Include for equipment. Number and size per manufacturer's recommendations or as indicated on the Drawings.

G. Supplementary Steel Framing: Standard structural steel shapes or Schedule 40 steel pipe.

H. Welding to Building Structural Members: Not acceptable except as indicated on the Drawings.

I. Concrete Bases (Housekeeping Pads): Include bases under floor mounted equipment, nominal 3-1/2 inch high. Comply with requirements in Division 03 for concrete. Coordinate with Division 03. Size bases 4 inch larger than equipment footprint in each direction unless noted otherwise on the Drawings.

2.3 SLEEVES

A. Materials, General: Schedule 40 galvanized steel pipe with unthreaded ends, cast iron pipe, or minimum 26 gage galvanized sheet steel. Use steel pipe for sleeves through floor slabs.

B. Sleeves in Fire and Smoke Rated Walls and Floors: Same material and thickness as was used when firestopping material was tested in accordance with procedures specified in Division 07. Firestopping will be furnished by a specialty subcontractor. Coordinate with requirements in Division 07.

C. Cast-in-Place Watertight Firestop Device in Fire Rated Floors (Contractor Option): Factory assembled device for installation in concrete floors. Assembly in accordance with ASTM E 814 and UL 1479. Device consists of outer sleeve lined with intumescent sleeve, radial extended flange attached to one end of sleeve for fastening to concrete formwork, and waterstop gasket/mid-body seal for embedment and sealing to concrete slab. Nonmetallic sleeve for nonmetallic through-penetrant pipe and metallic sleeve for metallic through-penetrant pipe. Flame spread rating of 0 and smoke developed rating of 5. Presealed Systems, HOLDRITE® HydroFlame™ Sleeving Systems, or approved.

D. Below Grade Watertight Wall and Slab On-Grade Floor Penetrations: Manufactured pipe-to-wall penetration closure. GPT Link-Seal® , Advance Products & Systems INNERLYNX®, Metraflex MetraSeals, Flexicraft Industries PipeSeal, or approved.

1. Description: Modular mechanical type assembly consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and wall opening.

Seal constructed to provide electrical isolation between pipe and wall, reducing cathodic reaction. Glass reinforced nylon pressure plates with zinc plated nuts and bolts.

2. Sleeves for New Construction: HDPE thermalplastic with full circle molded in waterstop plate and reinforcing ribs. Length to suit wall thickness. Inside diameter to suit seal requirements. Century-Line® Model CS.
3. Openings for Concrete Wall Construction or slab on grade floor penetrations: Core drill opening, inside diameter to suit seal requirement.

2.4 PIPE MARKERS AND COLOR BANDS

A. General: Manufacturer's standard preprinted, flexible or semi-rigid, permanent, color-coded, plastic sheet pipe markers. Comply with ASME A13.1 for label color and lettering size. Color code markers in accordance with Article "Pipe Markers and Color Bands Schedule" in this section. Include flow direction arrows.

B. Small Pipes: For external diameters less than 6 inch (including insulation), full band pipe markers.

C. Lettering: Indicate piping system using full name or abbreviation as indicated on the Drawings. Manufacturer's standard pre-printed nomenclature which best describes piping system in each instance acceptable, as selected by the A/E in cases of variance with names indicated on the Drawings.

D. Manufacturers: Seton, Brady Corp., Craftmark Pipe Markers, Marking Services Inc., or approved.

2.5 UNDERGROUND PIPE MARKERS

A. Manufacturer's standard, permanent, bright-burial service, not less than 6 inch wide by 4 mils thick. Tape color with printing which most accurately indicates type of service of buried pipe.

2.6 EQUIPMENT NAMEPLATES

A. General: Engraved stock melamine plastic laminate. Comply with ASTM D 709. Engraved with engraver's standard letter style of sizes and wording, black with white core (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate. Plastic strips with raised letters made by a marking device not acceptable. Include area (room) served on nameplate. Coordinate naming convention with the Owner. Color of nameplates for access doors for fire dampers, smoke dampers, and combination fire/smoke dampers as selected by the AHJ.

B. Thickness: 1/16 inch thick for nameplates up to 20 square inch or 8 inch length and 1/8 inch thick for larger nameplates.

2.7 VALVE TAGS

A. General: Manufacturer's standard solid plastic valve tags with printed enamel lettering, piping system abbreviation in approximately 3/16 inch high letters, sequenced valve numbers

approximately 3/8 inch high, and 5/32 inch hole for fastener. Coordinate naming convention with the Owner.

B. Valve Schedule: Typewritten on 8-1/2 by 11 inch bond paper. Tabulate valve number, piping system, system abbreviation (or as shown on tag), location of valve (room or space), and variation for identification (if any). Identify valves for emergency shutoff and similar uses in margin of schedule.

C. Fasteners: Manufacturer's standard solid brass beaded type chain, length as required for proper attachment of tags to valves manufactured specifically for that purpose.

D. Valve Schedule Frames: Glazed display frame with screws for removable mounting on masonry walls. Frame finished hardwood or extruded aluminum with SSB-grade sheet glass. Laminated plastic with reinforced mounting holes acceptable.

2.8 VALVE LOCATION DRAWINGS

A. General: Laminated plastic with reinforced mounting holes, 11 by 17 inch size, indicating locations of fire suppression, domestic water, natural gas, and hydronic shutoff valves on floor plan for each floor level. Color code valves for each system similar to pipe markers per Article "Pipe Markers and Color Bands Schedule" in this section. Include legend on each drawing.

2.9 CEILING ACCESS DOORS FOR FIRE SUPPRESSION, PLUMBING, AND HVAC EQUIPMENT

A. General: Universal 1-piece frame, flush type, welded steel ground smooth rounded safety corners, 1-piece spring hinge, slot screwdriver type cam latches, shallow 1-1/4 inch mounting flange. Include cylinder locked units in restrooms and areas accessible by students. Coordinate with general contractor so that lockable access doors are common-keyed for entire project. Where located in a painted surface area, units primed for painting; otherwise, polished chrome or stainless steel units, unless another type of finish is indicated.

B. Construction:

1. For sizes 16 inch by 16 inch and smaller: 16 gage panel, 18 gage flange.
2. For sizes 18 inch by 18 inch and larger: 14 gage panel, 16 gage flange.

C. Fire Rating: Where building fire-resistance rating is indicated, on the Drawings, doors shall be UL listed and labeled to meet fire rating requirements, except for those doors which are smaller than minimum size requiring fire ratings as recognized by governing authority.

D. Access Door Sizes:

1. One-Hand or Inspection Access: 8 inch by 5 inch.
2. Two-Hand Access: 12 inch by 6 inch.
3. Head and Hand Access: 18 inch by 24 inch.
4. Head and Shoulder Access: 24 inch by 24 inch.
5. Body Access: 30 inch by 14 inch.
6. Body plus Ladder Access: 36 inch by 24 inch.

E. Manufacturers: Milcor, Elmdor, Acudor Products Inc., or approved.

2.10 PERSONNEL PROTECTION

A. General: Where support angles, hangers, equipment supports and appurtenances, and similar items are exposed above floors, walkways, and maintenance access ways, cover such protrusions less than 6'-6" above floor with protective padding.

B. Protective Padding: Soft elastomeric foam material or equivalent with composite and component ratings per NFPA 255, ASTM E 84, or UL 723. Flame spread 25, smoke developed 50. Comply with requirements in Section 230700 for elastomeric insulation.

C. Finish: White field-applied finish of same manufacturer as protective padding.

2.11 PAINTING

A. General: Painting of work specified in mechanical sections which is exposed, including exterior exposed mechanical work, is specified in Division 09.

2.12 ROOF PENETRATIONS

A. Dektite flashings (flexible rubber boot flashing) at pipe penetrations through steel or composition roofs.

B. Use 4 pound per square foot seamless lead flashing skirt, minimum of 8 inch extending from pipe, with conical galvanized steel reinforcing boot and counterflashing fitting on built-up roofing.

C. Pipe Curb Assembly: Consist of galvanized steel 12 inch high roof curb with cant strip, integral base plate, 1-1/2 inch thick rigid fiberglass insulation, 2 inch by 2 inch pressure treated wood nailer, acrylic clad thermoplastic cap, fastening screws, graduated rubber boots, quantity to accommodate pipe sizes, and stainless steel clamps. The Pate Company Style PCC Series cap with Style PCA-1 curb or approved.

PART 3 - EXECUTION

3.1 MEASUREMENTS

A. Verify measurements at job site. Locate equipment and fixtures on centers of walls, openings, spaces, and similar locations except where noted otherwise. Check that piping, ducts, and similar elements clear openings.

3.2 INSTALLATION OF EQUIPMENT

A. Equipment Installation:

1. General: Install supports for equipment and appurtenances.

2. Suspended Equipment:

   a. Install concrete inserts before concrete is placed. Fasten inserts securely to forms. Where concrete with compressive strength less than 2500 psi is indicated, install reinforcing bars through openings at top of inserts.
   b. Install hangers from structure. Comply with requirements in Section 232116 for hanger rod sizes.
   c. Span between structural members with additional structural steel to mount equipment in locations shown. Do not fasten hangers to metal deck. Powder actuated fasteners not acceptable.

3. Floor-Mounted Equipment, General:

   a. Install machine and floor or foundation fastenings. Set equipment on concrete pads. For new construction, install anchor bolts through concrete equipment pads to structural concrete slabs. For existing construction, install concrete expansion anchors or concrete screws through concrete equipment pads to existing structural concrete slabs.
   b. Install equipment at locations and to dimensions indicated in the drawings using manufacturer's leveling screws, blocks, shims, or wedges. Do not distort equipment or baseplates.

4. Stands: Fabricate structural steel stands to support equipment not floor mounted or suspended from structure. Fabricate from structural steel members or steel pipe and fittings.
5. Manufacturer-Supplied Bases: Bases may be supplied by the equipment manufacturer if equivalent to base requirements specified above.

B. Equipment Seismic Restraints: Comply with requirements in Section 230548.

3.3 CUTTING AND PATCHING

A. General: Include in cost of fire suppression, plumbing, and HVAC work, cutting, coring, patching, and painting of existing walls, ceilings, and floors as required to accommodate work as indicated in the Contract Documents and specified in Divisions 21, 22, and 23 work, except where specifically shown on architectural drawings. Employ skilled workmen to perform cutting and patching and restore disturbed surfaces to original condition. Material and workmanship for patching shall be as specified in respective sections for general construction. If not specified, patch and paint to match existing surfaces. In addition, comply with requirements in Division 01.

B. Coordinate cutting work with other trades to minimize patching work and to protect existing finishes and structure from damage. Trenching shall not exceed 2'-0" in width unless approved by the A/E. Cutting of structural members shall be done with the A/E's approval.

C. During demolition efforts, cover duct open-ends and grille openings with taped on plastic sheet to keep construction dust out of the ducted system. Comply with requirements of Section 230520.

3.4 SLEEVES AND SEALING OF SLEEVES

A. Install sleeves for pipes and ducts for penetrations through cast-in-place concrete walls and floors, non-rated walls and floors, fire and smoke rated walls and floors, mechanical room walls and floors, and acoustical walls. Seal air and watertight. At Contractor's option, install cast-in-place watertight firestop devices through cast-in-place concrete fire rated floors.

B. Dimensions:

1. Annular Clear Space, General: Include annular clear space of approximately 1/4 to 1/2 inch. Size to accommodate insulation passing through sleeve.
2. Annular Clear Space for Sleeves through Fire and Smoke Rated Walls and Floors: Include annular clear space between sleeve and insulated or uninsulated surfaces of pipe, tubing, conduit, and wiring per firestopping manufacturer's installation requirements. Coordinate with requirements in Division 07 and insulation thicknesses specified in Section 230700.
3. Annular Clear Space for Sleeves through Mechanical Room Walls and Floor and Acoustical Walls: Comply with requirements in Section 230548.
4. Cast-in-Place Watertight Firestop Devices: Match uninsulated through penetrant pipe outside diameter size.

C. Extension: Wherever piping passes through floor slab above occupied space or equipment, install pipe sleeves extending 1 inch above floor, except where cast-in-place watertight firestop devices are installed.

D. Setting: Set sleeves or cast-in-place watertight firestop devices in place prior to pouring of concrete in new construction. Core drill and grout sleeves in place for unit masonry construction. Core drill existing concrete wall and floor construction.

E. Sealing of Sleeves:

1. Through Walls and Floors: Fill both ends of sleeve with non-hardening silicone sealer as specified in Division 07.
2. Through Fire and Smoke Rated Walls and Floors: Firestopping will be installed by a specialty subcontractor as specified in Division 07.
3. Through Acoustical Walls: Comply with requirements in Section 230548.

F. Sheet Metal Dams: Install 16 gage galvanized sheet metal dams around opening on top of floor for core drilled, saw cut, and formed openings through floor slabs without concrete curbs above occupied or equipment spaces. Solder or weld watertight. Seal and anchor to floor watertight. Install with minimum 1 inch projection above floor with 2 inch wide flange on floor.

G. Below Grade Watertight Wall and Slab-On-Grade Floor Penetrations: Install manufactured pipe-to-wall penetration closures where pipes pass through openings for below grade walls or slab on-grade floors.

3.5 FLASHINGS AT ROOF PENETRATIONS AND ROOFTOP EQUIPMENT SUPPORTS

A. General: Coordinate flashing for pipes, ducts, and conduits through roof surface and for equipment supports and similar items supported by or attached to roof deck with requirements in Division 07.

B. Pipe Curb Assembly: Install per manufacturer's installation instructions. Fill curb with foam insulation.

3.6 ACCESSIBILITY

A. General: Locate valves, dampers, controls, and similar components to be readily accessible. Install access doors to achieve accessibility. Access shall include, but not limited to, fire suppression, plumbing, and HVAC equipment above inaccessible ceilings and trap primers, valves, and similar items behind walls and above ceilings. Coordinate access door locations with the A/E.

B. Equipment:

1. Install equipment which requires periodic servicing or repairs to be readily accessible, except where specifically shown on architectural drawings. Otherwise, obtains A/E approval of location.
2. Piping, ducts, and conduit shall not interfere with required access.
3. Locate fire suppression, plumbing, and HVAC equipment above ceilings within 2 feet of access doors. If access to equipment is from bottom of unit, locate access door directly under unit sized large enough to accommodate access to internal components.

C. Access Tile Identification: Apply circular dot stickers on ceiling grid frame to indicate location of valves, dampers, controls, and equipment that requires maintenance. Color as selected by the A/E.

3.7 PIPE MARKERS AND COLOR BANDS

A. Install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment. Install to be visible on sides or bottom of pipe.

B. Locate pipe markers and color bands as follows wherever piping is exposed in occupied spaces, accessible maintenance spaces, and exterior non-concealed locations.

1. Near each valve and control device.
2. Near each branch, excluding short take-offs for fixtures and terminal units. Mark each pipe at branch where there could be question of flow pattern.
3. Near locations where pipes pass through walls and floors/ceilings or enter non-accessible enclosures.
4. At change in direction of pipe.
5. At access doors, manholes and similar access points which permit view of concealed piping.
6. Near major equipment items and other points of origination and termination.
7. Spaced intermediately at maximum spacing of 30 feet along each piping run, except reduce spacing to 15 feet in congested areas of piping and equipment. Stagger alternately on adjacent pipes.
8. On piping above removable acoustical ceilings, except omit intermediately spaced markers.

3.8 UNDERGROUND PIPE MARKER

A. During backfilling and placing of topsoil, install continuous marker tape located directly over buried line at 6 to 8 inch below finished grade for each exterior piping system. Where multiple small lines are buried in common trench that do not exceed overall width of 16 inch, install single line marker. For sewer drain fields and similar installations, mark only outer pipe lines of field.

3.9 PERSONNEL PROTECTION

A. General: Secure and permanently fasten elastomeric foam material in neat and smooth manner using band straps, clamps, snaps, or similar methods.

B. Finish: Apply 1 or 2 coats to result in uniform white color.

3.10 VALVE TAGS

A. Install valve tags on valves and control devices in each piping system. Install wherever destination or identity of pipe is not visible from valve. Fasten with chain to valve stem.

B. Tags for check valves, valves within factory-fabricated equipment units, plumbing fixture supply stops, hose bibbs, wall hydrants, shutoff valves at HVAC terminal devices and similar rough-in connections of end-use equipment not required. Include tagged valves in valve schedule for each piping system.

C. Install valve schedule in mechanical rooms and in custodial rooms or as directed by the A/E.

3.11 VALVE LOCATION DRAWINGS

A. Install complete set of floor plan drawings of valve locations, wall mounted, in mechanical rooms.

3.12 EQUIPMENT NAMEPLATES

A. Install nameplates on or near each major item of mechanical equipment and each operational device. Install on accessible sides of equipment for the following general categories of equipment, operational devices, and for equipment scheduled on the Drawings:

1. Chillers
2. Pumps
3. Fans
4. Packaged HVAC units
5. Tank and pressure vessels
6. Control panels
7. Air handling units
8. Domestic water heaters
9. Fire dampers, smoke dampers, and combination fire/smoke dampers

B. Install with self-tapping stainless steel screws or steel rivets, except use of contact-type permanent adhesive where screws cannot or should not penetrate substrate is acceptable.

3.13 EARTHWORK

A. Perform earthwork required for installation of fire suppression, plumbing, and HVAC work below grade. Provide earthwork meeting requirements in this article, UPC, and Division 31, whichever is most stringent.

B. Locate and protect existing utilities and other underground work in manner which will ensure that no damage or service interruption will result from excavating and backfilling. Perform excavation in a manner which protects walls, footings, and other structural members from being disturbed or damaged in any way.

C. Coordinate excavations with weather conditions to minimize possibility of washouts, settlements and other damages and hazards.

D. Do not excavate until required materials are on site and the work is ready to proceed without delay so that total time lapse from excavation to completion of backfilling will be minimal. Remove excavated material from jobsite. Reuse of excavated materials from trenches inside existing structures acceptable upon approval by the A/E.

E. Excavate trenches of necessary width for proper laying of pipe with banks as nearly vertical as possible from trench bottom to 12 inch above top of pipe and conduit as detailed on the Drawings. Grade trench bottoms to provide uniform undisturbed bedding for each section of pipe. Form holes and depressions for joints after trench bottom has been graded. Provide temporary pumping equipment to keep excavation free from water. Install pipe bedding in rock excavation consisting of not less than 6 inch of sand or equivalent material. For non-metallic sewer and storm drain piping (for example, PVC, CPVC, PP, PE, PVDF, and ABS), comply with ASTM D 2321.

F. Store native excavated material (temporarily) near excavation in manner which will not interfere with or damage excavation or other work.

G. Provide bracing and shoring as necessary to maintain stability of excavation and to comply with safety codes.

H. Provide imported material from off-site for use as the final backfill if excavated material is not approved by the A/E for reuse.

I. Backfill trenches only after completion of pressure tests and inspection by the A/E. Install initial backfill material under, around, and between pipe and sides of trench by hand, shovel tamped in place. Cover in 6 inch layers to 12 inch thickness over top of pipe. For final backfill, fill and tamp remainder of backfill material in 6 inch layers. Provide backfill materials as follows:

1. For metallic sewer and water piping, use pea gravel.
2. For gas piping, use sand.
3. For non-metallic piping (for example, PVC, CPVC, PP, PE, PVDF, and ABS), comply with ASTM D 2321.

J. Wherever paving or future paving is indicated over backfill and areas where mechanical work is located outside building perimeter, such as for oil interceptors, oil tanks, and grease interceptors, where heavy equipment may impact piping, provide remainder of backfill with granular subgrade backfill material (Butler fill).

K. Compacting:

1. Perform compacting individually, for each 6 inch layer (maximum) loose thickness of initial and final backfill. Comply with ASTM D 1557. Where roadway or parking area surfaces will be placed over backfill and to 10 feet beyond building perimeter compacted to 95 percent of maximum density. Elsewhere, 90 percent. Test in accordance with Divisions 01 and 02.
2. Take special care in compacting under services where they enter building to prevent settling. The Contractor fully responsible for damage to piping and property as result of settling around service piping.

L. Dispose of surplus earth off-site in a suitable location.

M. Place and maintain barricades, construction signs, torches, lanterns and guards as required during periods of open excavation to protect persons from injury and to avoid property damage.

N. Leave premises thoroughly clean at completion of earthwork.

O. Installation of Piping in Backfilled Areas: Wherever piping is to be installed in areas which have been excavated below pipe inverts, for any purpose, install piping to prevent subsequent settlement. Do not install piping until backfill is to full compaction, completed to minimum 18 inch above pipe to be installed. Install piping in re-excavated trenches and backfill as previously specified.

P. Where subsidence is measurable or observable at mechanical work excavations during project warranty period, remove surface (pavement, lawn or other finish), add backfill material, compact, and replace surface treatment. Restore appearance, quality and condition of surface or finish to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.14 PAINTING

A. General:

1. Paint equipment, piping, sheet metal work, and mechanical system appurtenances inside mechanical rooms and machine rooms.
2. Painting in finished rooms is specified in Division 09.
3. Painting of metal jacketing specified in Section 230700 not required.

B. Application:

1. Thoroughly clean surfaces to be painted to remove dirt, grease, and scale. Wash galvanized surfaces with mild solution of acid prior to painting.
2. Paint insulated surfaces and covered piping with 1 primer coat and 2 finish coats.

3. Paint exposed equipment, ducts, pipes, and supports with 1 primer coat and 2 finish coats. Equipment painted at the factory with lacquer or enamel need not be painted. Touch up damaged areas with paint to match factory color.
4. Paint supporting devices for mechanical systems specified to be painted.**]**

3.15 MISCELLANEOUS EQUIPMENT AND FIXTURE CONNECTIONS

A. General: Install piping, ducts, and make final mechanical connections in accordance with manufacturer's recommendations for Owner-furnished equipment and fixtures, and equipment and fixtures specified in Divisions 01 through 14. This applies to work of, but not limited to, Sections 224000, 232113, and 233300.

B. Coordination: Perform on-site review and refer to manufacturer's Shop Drawings for details of connections. Perform rough-in at locations to conveniently serve items.

3.16 REVISIONS, ALTERATIONS, AND CONNECTIONS TO EXISTING MECHANICAL SYSTEMS

A. General: Concealed equipment, piping, and ducts of record are indicated in the Contract Documents. Since these are not necessarily exact with respect to location or completeness, take the following steps:

1. Inspect existing conditions of work, including existing equipment, piping, and ducts, and compare to the Contract Documents for extent and description of new work.
2. Where connections are required to existing piping and ducts, keep shutdown period to a minimum and restore services promptly to existing building. Comply with requirements of Article "Continuity of Existing Utility Services" in Section 230500.
3. Should any unknown piping and ducts be encountered during course of work, notify the A/E of such discovery.

3.17 CLEANING AND HOUSEKEEPING

A. General: Comply with requirements in Division 01 and Section 233400 for air handling equipment.

B. Remove debris, cuttings, crates, cartons, and similar items, created by Divisions 21, 22, and 23 Work at regular intervals. Perform at sufficient frequency to eliminate hazard to the public, other trades personnel, building, and the Owner's employees.

C. Before Substantial Completion, carefully clean equipment, fixtures, exposed ducts and piping, and similar items. Remove construction labels, dirt, dust, cuttings, paint, plaster, mortar, concrete, and similar items.

3.18 COMMISSIONING

A. Equipment and systems referenced in this section shall be commissioned per Section 230800. The Contractor has specific responsibilities for scheduling, coordination, test development, testing and documentation.

3.19 PIPE MARKERS AND COLOR BANDS SCHEDULE

PIPE SYSTEM	COLOR
Domestic Cold Water	White Letters on Green
Domestic Hot Water	White Letters on Green
Domestic Hot Water Circulation	White Letters on Green
Non-Potable Cold Water	White Letters on Green
Non-Potable Hot Water	White Letters on Green
Non-Potable Hot Water Circulation	White Letters on Green
Soil, Waste, and Vent	Black Letters on Yellow
Storm Drain and Rainwater Leader	White Letters on Green
Condensate Drain	Black Letters on Orange
Fire Suppression	White Letters on Red
Hydronic Heating Water Supply	White Letters on Green
Hydronic Heating Water Return	White Letters on Green
Chilled Water Supply	White Letters on Green
Chilled Water Return	White Letters on Green
Glycol Solution Supply	Black Letters on Orange
Glycol Solution Return	Black Letters on Orange
Refrigerant Liquid	Black Letters on Yellow
Refrigerant Suction	Black Letters on Yellow

OUTSIDE PIPE DIAMETER (INCLUDING INSULATION) (INCH)	MINIMUM LENGTH OF LABEL COLOR FIELD (INCH)	MINIMUM LETTER HEIGHT (INCH)
3/4 to 1-1/4	8	1/2
1-1/2 to 2	8	3/4
2-1/2 to 6	12	1-1/4
8 to 10	24	2-1/2
Larger than 10	32	3-1/2

3.20 PAINTING SCHEDULE

SHEET METAL SYSTEM	COLOR
Supply Air Ducts	Blue

SHEET METAL SYSTEM	COLOR
Return and Relief Air Ducts	Purple
Exhaust Air Ducts	Green

3.21 MINIMUM TRENCH WIDTH FOR NON-METALLIC PIPES

PIPE SIZE (INCH)	TRENCH WIDTH PER ASTM D 2321 (INCH)
4	21
6	23
8	25
10	27
12	30

NOTE: REFER TO ASTM D 2321, TABLE 6-1 FOR LARGER PIPE SIZES.

END OF SECTION 230510

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Description: The Work includes flush out (burn-in) utilizing outside air to be completed after Substantial Completion and prior to the Owner occupancy after significant finish materials have been installed. Refer to additional requirements in Section 230800.

B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to the Work in this section.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.

1.3 SUBMITTALS

A. Comply with requirements in Division 01 and Section 230500.

B. Performance Data: Include the following in the written plan:

1. Develop and submit written plan describing how 90 percent outside air flush out will be achieved during construction.
2. Plan shall describe how 60 F to 65 F building temperature will be maintained, with relative humidity no higher than 60 percent and supporting calculations achieving minimum of 2 building volume air changes per hour.
3. Plan shall also include how occupied area air quality will be maintained, including installation and periodic replacement of special filters and what measures will be taken to disable and protect return air openings during flush out periods.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

3.1 GENERAL

A. Prior to installation, inspect ducts for dust and confirm that oil film has been completely removed. Remove any dust, dirt, and remaining oil.

B. Prior to system start-up, inspect ducts again for dust and other debris that may have collected during construction. Immediately remove any dust and debris using a HEPA vacuum.

C. During construction provide temporary construction ventilation by continuously ventilating affected spaces during installation of materials that emit volatile organic compounds (VOC) and for at least 72 hours after installation. Ventilate longer than 72 hours if necessary to completely remove odors. Exhaust air directly to outside; do no recirculate to other enclosed spaces. If continuous ventilation is not possible using building's HVAC system for temporary ventilation, then ventilate via open windows and temporary fans.

D. After construction with new finishes installed, install new filtration media and flush out building continuously, 24 hours per day, using 90 percent tempered outside air for at least 2 weeks after Substantial Completion of construction is achieved and before building is occupied. Maintain internal air temperature of at least 60 F and relative humidity no higher than 60 percent. If the Contractor is required to perform touch-up work during this time, provide temporary construction ventilation during the Work and extend building flush out by minimum of 4 days after touch-up installation.**]**

E. Perform final flush out during non-occupied hours for minimum 7 days on 90 percent outside air after the Owner has moved all furniture in.

F. Maintain building temperature during flush out period at not less than 60 F unless otherwise approved in writing by the Owner.

G. Following final flush out, immediately replace filters, types as specified in Section 234100.

3.2 COMMISSIONING COORDINATION

A. Building systems commissioning may be performed concurrently with the 14 day flush out period if commissioning is performed during normal work hours not exceeding 8 hours per day. In effect, during each 24 hour period, 8 hours may be devoted to commissioning whereas remaining 16 consecutive hours shall be devoted to building flush out.

B. Complete air and water balancing work prior to start of building HVAC commissioning unless otherwise approved in writing by the Owner.

3.3 INSPECTION

A. Prior to start of flush out period, notify the Owner and the A/E in writing that building is ready for inspection to verify completion. Allow 3 workdays after receipt of such notice for the Owner and the A/E to perform the inspection.

B. Notice shall certify that finishes have been installed; ductwork, plenums and air handling equipment are clean, and free of dust, oil and other contaminants; air and water balancing have been completed; HVAC components have been tested; and start-up process has been completed.

C. The Owner will issue written approval to start flush out period within 3 working days after receipt of notice or respond with remedial actions that need to be performed before approval can be issued.

3.4 SPECIAL CONSIDERATIONS FOR OCCUPIED AREAS

A. When the building is partially occupied during construction, whether new or renovated facilities, operate the HVAC system to isolate occupied areas from where construction is occurring.

B. Protect existing HVAC outside air intake and return air plenums from pollutant sources created by construction, including equipment exhaust and dust and odor pollution.

END OF SECTION 230512

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Description: The Work includes factory and field installed motors, motor starters, and associated appurtenances.

B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to the Work in this section.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.

B. Codes and Standards:

1. IEEE 112, IEEE Standard Test Procedure for Polyphase Induction Motors and Generators.
2. NEMA MG 1, Motors and Generators.
3. NFPA 70, National Electrical Code (NEC).
4. UL 508A, Standard for Industrial Control Panels.
5. UL 1995, Heating and Cooling Equipment.

C. Comply with applicable NEMA standards and refer to NEMA standards for definitions of terminology herein. Comply with NFPA 70 for workmanship and installation requirements and to applicable Division 26 sections.

1.3 SUBMITTALS

A. Comply with requirements in Division 01 and Section 230500.

B. Product Data: Submit manufacturer’s technical product data and maintenance data for the following:

1. Motor
2. Motor starters

1.4 WARRANTY

A. Warrant motors controlled by ECM or variable frequency drives (VFDs) specified in Section 230915 for 2 years after Substantial Completion date. Warranty shall cover materials, labor, and travel time. Make available replacement within 48 hours of initial notification.

PART 2 - PRODUCTS

2.1 MOTORS

A. Motor Characteristics: Except where more stringent requirements are indicated, and except where required item of mechanical equipment cannot be obtained to meet requirements in this article. Comply with the following requirements for motors for mechanical work:

1. Comply with NEMA MG 1 unless otherwise indicated.
2. Temperature Rating: Rated for 40 C ambient temperature and at 3300 foot elevation with maximum 50 C temperature rise for continuous duty at full load (Class A insulation).
3. Capacity and Torque: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, but without exceeding nameplate ratings or considering service factor.
4. Phases and Current Characteristics: Squirrel-cage induction polyphase motors for 1/2 hp and larger. Permanent-split capacitor or capacitor-start single-phase motors for 1/3 hp and smaller, except 1/6 hp and smaller may, at equipment manufacturer's option, be split-phase type. Coordinate current characteristics with power specified in Division 26 sections and with individual equipment requirements specified in other Division 22 and 23 sections.
5. Do not purchase motors that are either factory or field installed until power characteristics and rotation direction have been confirmed.
6. Service Factor: 1.15 for polyphase motors and 1.35 for single-phase motors.
7. Motors 2 Hp and Larger: Include factory or field installed shaft grounding ring to prevent damage to motor bearings from induced shaft currents. Electro Static Technology-ITW AEGIS SGR^{TM}, Shaft Grounding Ring or approved.

B. Motor Construction: General purpose, continuous duty motors, Design "B", except "C" where required for high starting torque.

1. Frames: NEMA standard.
2. Bearings: Antifriction ball or sleeve bearings with inner and outer shaft seals, greaseable except permanently sealed where motor is normally inaccessible for regular maintenance. Where belt drives and other drives produce lateral or axial thrust in motor, bearings designed to resist thrust loading. Refer to other Division 22 and 23 sections for fractional-hp light-duty motors where sleeve-type bearings are permitted.
3. Enclosure Type: Except as otherwise indicated open dripproof motors for indoor use where satisfactorily housed, and guarded dripproof motors where exposed to contact by employees and building occupants. Totally enclosed fan cooled for outdoor use. Refer to other Division 22 and 23 sections for other enclosure requirements.
4. Overload Protection: Include for each motor. Built-in (manual reset) for 120, 208, and 277 V, single phase motors.
5. Efficiency: Premium efficiency.
6. Power Factor: Minimum 85 percent under full load conditions. Where less than 85 percent, include power factor correction to minimum 90 percent.

7. Electronically Commutated Motors (ECMs): Variable speed DC brushless motor with single phase integrated controller/inverter. Motor designed for synchronous rotation to overcome reverse rotation. Rotor permanent magnetic type with near zero rotor losses. Motor with built-in soft start, soft speed change ramps, and permanently lubricated ball bearings. Include anti-back rotation feature or include motor designed to overcome reverse rotation without effect on motor life expectancy. Include device to limit electric harmonic distortion. General Electric ECM™ or approved.
8. Motors Controlled by VFDs: Inverter duty, Class F temperature rise, Class H insulation, and meeting NEMA MG 1, Part 31. Compatible with VFDs specified in Section 230915 using insulated gate bipolar transistors (IGBTs).

    a. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
    b. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
    c. Turndown: Capable of turndown ratio of 10 to 1.
    d. Include factory or field installed shaft grounding ring to prevent damage to motor bearings from VFD induced shaft currents. Electro Static Technology-ITW AEGIS SGR™ Shaft Grounding Ring or approved.

9. Multi-Speed Motors: Two speed, two winding, variable torque, pole-changing type with reduced speed.
10. Nameplate: Include, indicating full identification of manufacturer, ratings, characteristics, construction, special features, and similar information as required by NEMA MG 1.

C. Manufacturers: Except where item of mechanical equipment (which otherwise complies with requirements in this section) is integrally equipped with motor produced by another manufacturer, include motors by one of the following manufacturers: Baldor Electric Motor Company, General Electric Co., Marathon™ Electric Motors, Reliance Electric Motors, Toshiba International Corp., Siemens Corporation, Emerson Climate Technologies, US Electrical Motors, Gould Electric Motor, Louis Allis, Lincoln Motors, or Magnetek, Inc.

2.2 MOTOR STARTERS

A. General: Comply with requirements in Division 26 for factory installed starters. Field installed starters are specified in Division 26 work.

2.3 EQUIPMENT SHORT CIRCUIT CURRENT RATING

A. Mechanical equipment, packaged systems, control panels, motor starters, motor controllers, variable frequency drives and similar equipment shall carry a Short Circuit Current Rating (SCCR) equal to or greater than available fault current delivered from electrical system. Include visible factory nameplate for such equipment indicating SCCR of equipment in accordance with UL 1995 and UL 508A.

PART 3 - EXECUTION

3.1 MOTORS

A. Where motors are furnished for field mounting, install motors on motor mounting systems in accordance with motor manufacturer's instructions, securely anchored to resist torque, drive thrusts, and other external forces inherent in mechanical work. Secure sheaves and other drive units to motor shafts with keys and Allen set screws, except motors of 1/3 hp and less may be secured with Allen screws on flat surfaces of shaft. Unless otherwise indicated, set motor shafts parallel with machine shafts.

3.2 STARTERS

A. Coordinate with Division 26 work to install starters and wiring devices near motors or as indicated on the Drawings. Securely support and anchor in accordance with manufacturer's installation instructions. Locate for proper operational access, including visibility for safety.

3.3 EQUIPMENT AND MOTOR CONNECTIONS

A. Install flexible-conduit connection to motor and equipment for packaged and non-packaged equipment that is factory assembled. Comply with applicable provisions of Division 26 sections for wiring materials and wiring services.

B. Refer to Division 26 sections for installation requirements. Division 22 and 23 shall provide work not indicated in Division 26 for a complete and operating system. Where a conflict occurs between Division 22 and 23 and Division 26, Division 22 or 23 Contractor shall provide work for a complete and operating system. Refer to schedule included in this section for additional information.

3.4 EQUIPMENT FABRICATION

A. Fabricate mechanical equipment for secure mounting of motors and other electrical items including in work. Include permanent alignment of motors with equipment, or adjustable mountings as applicable for belt drives, gear drives, special couplings and similar indirect coupling of equipment. Install safe, secure, durable, and removable guards for motor drives, arranged for lubrication and similar running maintenance without removal of guards.

3.5 COMMISSIONING

A. Equipment and systems referenced in this section shall be commissioned per Section 230800. The Contractor has specific responsibilities for scheduling, coordination, test development, testing and documentation.

3.6 MECHANICAL – ELECTRICAL INTERFACE SCHEDULE

A. Establishing the separation of work between trades and subcontractors is not within scope of these Contract Documents. The following schedule is proposed for assistance in bidding only.

B. Unless otherwise indicated in the Contract Documents, mechanical equipment and controls are suggested to be furnished, installed, and wired in accordance with the following schedule. Coordinate work with Division 26 sections.

ITEM	FURNISHED BY	INSTALLED BY	POWER WIRING BY	CONTROL WIRING BY
1. Equipment Motors:	M	M	E	M
2. Magnetic Motor Starters and Equipment Connections:				
a. Automatically Controlled with or without HOA Switches:	E	E	E	M
b. Manually Controlled:	E	E	E	E
c. Furnished with Mechanical Equipment, Factory Mounted:	M	M	E	M
d. Furnished with Mechanical Equipment, Field Mounted:	M	E	E	M
3. Disconnect Switches and 120 V Receptacles per IMC and NEC:	E	E	E	--
4. Manual Motor Starters, Thermal Overload Switches:	E	E	E	--
5. Combination Fire/Smoke Dampers, Smoke Dampers:	M	M	E	E
6. Section 230900 Automatic Temperature Controls: Valve and Damper Actuators, Low Voltage Electric Thermostats, Switches, other Miscellaneous Controls:	M	M	M	M
7. Electric Baseboard Heaters, Cabinet Heaters, Unit Heaters:	M	M	E	M
8a. Duct Smoke Detectors:	E	M	E	E
8b. Relays and Ancillary Devices Associated with HVAC Unit Shutdown by Duct Smoke Detectors:	E	E	E	E
9. Section 230533 Electrical Heat Trace:	M	M	E	M
10. Variable Frequency Drives:	M	M	E	M
11. Section 230900 Control Panels:	M	M	E	M

M = Division 22 and 23, Mechanical
E = Division 26, Electrical

END OF SECTION 230513

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Description: The Work includes electrical heat trace and associated appurtenances.

B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to the Work in this section.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.

1.3 SUBMITTALS

A. Comply with requirements in Division 01 and Section 230500.

B. Product Data: Submit manufacturer's technical product data and maintenance data for the following:

1. Electrical heat trace for insulated pipes.
2. Electrical heat trace for snow melting systems.
3. Blank copy of start-up and test report forms.

C. Test Reports:

1. Field start-up and test reports.
2. Submit completed copy of report and include copy in the Operations and Maintenance Manual.

PART 2 - PRODUCTS

2.1 ELECTRICAL HEAT TRACE FOR INSULATED PIPES

A. General: Self-regulating with two 16 gage tinned copper bus wires imbedded in self-regulating polymer core that varies its power output to respond to temperature along its length, allowing heat tracing to be crossed over itself without overheating. UL listed and labeled. Heater with minimum self regulation factor of minimum 90 percent. Select for 5 Watts per foot at 50 F with 1 inch thick fiberglass insulation.

B. Freeze Protection: Select length of element per foot of pipe and number of valves in accordance with manufacturer's recommendation based on thickness of fiberglass insulation specified in Section 230700, 30 F temperature difference, and 35 F pipe maintenance temperature.

C. Pipeline Sensing Thermostat: Include under insulation, set at 35 F to directly control heat tracing system.

D. Accessories: Include power connection kit, splice and tee kits, end seals, end cable ties, to suit pipe installation requirements. Include power indicator light.

E. Manufacturers: Raychem XL-Trace, Chromalox, Thermon, or approved.

F. Digital Controller:

1. Enclosure: Fiberglass reinforced plastic (FRP), NEMA 4X.
2. Protection: Internal adjustable ground fault protection device (GFPD) with ground fault sensing, alarm, and trip functions. Include built-in self test to verify system functionality.
3. Monitoring: Include alarm relay and dry contact relay and gateway to communicate to DDC system specified in Section 230900 to monitor temperature, ground fault, current draw, and power consumption and associated alarms.
4. Manufacturer: DigiTrace® Model C910, Environmental Technology, or approved.

PART 3 - EXECUTION

3.1 INSPECTION

A. General: Verify installation conditions as satisfactory to receive the Work of this section. Do not install until any unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

3.2 PREPARATION

A. Field Measurements: Field verify locations of new and existing work prior to commencing the Work of this section.

B. Protection: Protect surrounding areas and surfaces to preclude damage from the Work of this section.

3.3 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

A. General: Install, apply, erect, and perform the Work in accordance with Article “Quality Assurance” provisions, specifications, and manufacturer’s installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

B. Coordinate required electrical and control installation work with Division 26 and Section 230900.

3.4 EQUIPMENT CONNECTIONS

A. Refer to Division 26 sections for installation requirements. Division 23 shall provide work not indicated in Division 26 for complete and operating system. Where conflict occurs between Division 23 and Division 26, Division 23 contractor shall provide work, including installation by licensed electrician, for complete and operating system.

3.5 ELECTRICAL HEAT TRACE FOR INSULATED PIPES

A. General: Install on piping located outdoors and as indicated on the Drawings between pipe and insulation in accordance with manufacturer's instructions after pipes have been pressure tested.

B. Tests: After installation of heat tracing, and before and after installing insulation, test using 2500 V DC megger. Minimum insulation resistance shall be 20 to 1,000 megohms regardless of length. Test both heating cable wires to verify connection of splices and tees.

C. Labels: Install "ELECTRICAL HEAT TRACED" labels on outside of jacket at 10 foot intervals.

3.6 COMMISSIONING

A. Equipment and systems referenced in this section shall be commissioned per Section 230800. The Contractor has specific responsibilities for scheduling, coordination, test development, testing and documentation.

END OF SECTION 230533

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Description: The Work includes products to isolate building structure and occupied spaces from vibration transmission for mechanical equipment and distribution systems. Isolation work shall include, but not necessarily be limited to, the following:

1. Supported isolation of motor-driven equipment.
2. Isolation support of air-handling housings.
3. Isolation support of piping, piping risers, and ductwork.
4. Penetration isolation of pipes and ductwork through walls, floors, and ceilings.
5. Flexible connections of ductwork and piping to equipment.

B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions, and Division 01 sections apply to the Work in this section.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.

1. Codes and Standards: ASTM C 94, Standard Specification for Ready-Mixed Concrete.
2. ASTM G 21, Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
3. NFPA 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems.
4. NFPA 90B, Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
5. NFPA 701, Standard Methods of Fire Tests for Flame Propagation of Textiles and Films.

1.3 SUBMITTALS

A. Comply with requirements in Division 01 and Section 230500.

B. Product Data: Submit manufacturer’s technical product data for the following:

1. Vibration isolation mounts.
2. Bases.
3. Vibration isolation hangers.
4. Miscellaneous supports.
5. Flexible connectors.
6. Miscellaneous products.

C. Shop Drawings:

1. Bases and vibration isolation installation, including sizes, type, and placement of isolators. Include total operating weight of each isolated piece of equipment.

2. Shop Drawings shall be stamped and signed by professional engineer licensed in engineering in state in which the Work is performed.
3. Calculations: Sizing and weight distribution for vibration isolators and bases. Calculations shall be stamped and signed by professional structural engineer licensed in engineering in state in which the Work is performed.

D. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slide rails, base weights, and equipment static loads.

E. Isolator Schedule List: List size, type, load, and static deflection of each isolator. Number and color code to show its location. Mark code number and color on Shop Drawings, on each isolator, and on each base to ensure that the Contractor will place them in the proper locations.

F. Procedures: Submit procedures and installation instructions for setting and adjusting vibration isolators and bases.

G. Final Inspection Report: Vibration isolation manufacturer shall prepare and submit written report documenting final inspection and certifying that vibration isolators are properly installed and adjusted.

1.4 CONTRACTOR RESPONSIBILITY FOR VIBRATION ISOLATION

A. General: A single supplier shall furnish isolation mounts, pads, sway braces, related hardware, and fabricate isolation bases for the Project unless otherwise specified.

B. Responsibility: This supplier shall be responsible for selection and installation supervision of vibration isolators. Prepare engineering drawings and details and submit to the A/E. Perform installation supervision and provide adjustment instructions.

1.5 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Section 232113 – Hydronic Piping Systems: Flexible connectors.

B. Section 233100 – Air Distribution: Flexible connectors.

1.6 VIBRATION ISOLATION, GENERAL

A. Description:

1. Balanced set of vibration isolators for each item of equipment listed in Article “Vibration Isolation Schedule” in this section.
2. Vibration isolation of piping and ducts as indicated in the Contract Documents and listed in Article “Vibration Isolation Schedule” in this section.
3. Provide components or materials not specifically mentioned herein, but necessary for proper vibration isolation of equipment.

B. Rotating Equipment Criteria: Maximum vibration levels at each bearing, while in operation not to exceed 0.08 inch/sec. If operating vibration velocities exceed this criteria, repair or replace equipment at no expense to the Owner until approval of equipment is given by the A/E.

PART 2 - PRODUCTS

2.1 GENERAL

A. Manufacturers: Mason Industries, Inc., Amber/Booth, Kinetics Noise Control, Vibration Mountings and Controls, Inc., Vibro-Acoustics®, Korfund Dynamics Corporation, California Dynamics Corp (CalDyn), TOLCO™, or approved. Mason Industries model numbers are listed.

2.2 VIBRATION ISOLATION MOUNTS

A. Spring S-1, Open Spring:

1. Description: Free-standing and laterally stable, complete with 1/4 inch thick neoprene acoustical cup or pad between base plate and support.
2. Construction:

    a. Leveling bolts rigidly bolted to the base frame with locking cap screws.
    b. Spring diameter no less than 0.8 of compressed height of spring at rated load, with minimum additional travel to solid equal to 50 percent of rated deflection.

3. Manufacturer and Model: Mason Industries SLF.

B. Spring S-2, Housed Seismic Restraint Spring:

1. Description:

    a. Designed to resiliently resist seismic forces in all directions.
    b. Snubbing in all directions with adjustment to limit upward, downward, and horizontal travel to maximum of 1/4 inch before contacting snubbers.
    c. Spring shall have seismic rating certified as an OSHPD Pre-approved Anchorage (OPA) from Office of Statewide Health Planning and Development (OSHPD) for State of California.

2. Construction:

    a. Leveling bolts rigidly bolted to the equipment with height-saving brackets and 1/4 inch neoprene waffle pad bonded to bottom of baseplate.
    b. Spring diameter no less than 0.8 of compressed height of spring at rated load, with minimum additional travel to solid equal to 50 percent of rated deflection.
    c. Maximum clearance of 1/4 inch maintained around restraining bolts and between housing and spring to prevent interference with spring action.

3. Manufacturer and Model: Mason Industries SLR or SLRS Series.

C. Neoprene N-1, Neoprene Mount:

1. Description: Captive neoprene mounting within steel housing for minimum static deflection of 0.2 inch in compression.
2. Construction: Captive steel insert embedded in neoprene with load plate to permit bolting to supported equipment. Housing includes base plate with bolt holes.
3. Manufacturer and Model: Mason Industries BR.

2.3 BASES

A. General: Bases for vibration isolated equipment as indicated in the Contract Documents. Bases may be furnished by equipment manufacturer subject to meeting these specifications. Submit calculations verifying factory base stiffness is equivalent to stiffness of base specified in Article “Vibration Isolation Schedule” in this section.

B. Base B-1, Supported Integral Structural Steel Frame:

1. Description: Structural steel support members, with welded-on isolator support brackets and pre-located and drilled anchor bolt holes. Coordinate isolator locations for each piece of equipment as required.
2. Construction:

    a. Structural members of minimum section depth equal to 10 percent of longest span between support isolators and of sizes and shapes required for equipment to be supported.
    b. Isolator support height saving brackets welded to structural base for lowest possible mounting height of supported equipment.

3. Criteria:

    a. Rigid, distortion free mounting base for supported equipment, allowing no excessive differential motion between driving or driven equipment components.
    b. Frame shall allow for minimum operating clearance of 1 inch between structural steel frame and floor or housekeeping pad.

4. Manufacturer and Model: Mason Industries WF.

C. Base B-2, Concrete Inertia Base:

1. Description: Rectangular structural steel concrete pouring forms for floating concrete base, welded or bolted construction. Base for split case pumps large enough to support suction and discharge elbows.
2. Construction:

    a. Structural members minimum 1/12 of longest dimension of base but not less than 6 inch. Base depth minimum 12 inch unless recommended by supplier for mass or rigidity.
    b. Half inch reinforcing bars welded in place running in both directions at 6 inch centers located in layer 1 1/2 inch above bottom of base.
    c. Height savings brackets to maintain minimum 2 inch clearance below base.
    d. Steel templates for anchor bolt sleeves and anchor bolts.

3. Manufacturer and Model: Mason Industries K or BMK Series.

D. Base B-3, Hung Integral Structural Steel Frame:

1. Description: Four hanger rods attached to roof or floor framing system. Rods sufficient to carry 5 times overload without yielding or failure. Include H-1 Type hangers located on 4 hanger rods, in series with supported load. Attach rods to support “ears” or connect to an assembly using structural steel shapes. Include brackets and bolt equipment to frame supports.

2.4 VIBRATION ISOLATION HANGERS

A. Hanger H-1, Spring Hanger:

1. Description: Combination of steel spring and fiberglass or neoprene isolator placed in series and encased in welded steel bracket.
2. Criteria:

   a. Spring diameter no less than 0.8 of compressed height of spring at rated load with minimum additional travel to solid equal to 50 percent of rated deflection.
   b. Select hanger to carry 5 times overload without failure and to allow up to 15 degrees of rod misalignment in all directions without metal-to-metal contact or other short circuit.

3. Manufacturer and Model: Mason Industries 30N.

B. Hanger H-2, Neoprene Hanger:

1. Description: Neoprene-in-shear or fiberglass isolator encased in welded steel bracket.
2. Criteria: Minimum 0.35 inch operating static deflection.
3. Manufacturer and Model: Mason Industries HD.

2.5 MISCELLANEOUS SUPPORTS

A. Type IP-1, Isolation Pad:

1. Description: Neoprene waffle pads, with 2 layers of 3/4 inch thick neoprene separated by 16 gage galvanized sheet metal shim and load distribution plates. Size to limit surface pressure to 45 pounds per square inch. Where bolts are used to secure equipment, isolate bolts from equipment with neoprene washers and grommets. Allow no metal-to-metal contact between bolt and equipment.
2. Manufacturer and Model: Mason Industries Super W.

B. Type WB-1, Neoprene Washers and Bushings:

1. Washer-bushing manufactured of bridge bearing neoprene.
2. Washer-bushing maximum loading not to exceed 1000 psi.
3. Washer-bushing to be used such that direct contact between bolt and equipment is eliminated.
4. Manufacturer and Model: Mason Industries HG.

2.6 FLEXIBLE CONNECTORS

A. General:

1. Comply with NFPA 90A and NFPA 90B.
2. Fabric shall meet NFPA 701 and resist mildew per ASTM G 21.

B. Ducts:

1. Indoor Applications:

a. Description: Flexible, woven fiberglass with neoprene coating, resistant to alkalies and gasoline and unaffected by mildew, 22 oz. per sq. yd, temperature range from minus 40 F to 200 F.
b. Manufacturers: Duro-Dyne Neoprene (Standard Grade), Ventfabrics, Inc., Ductmate Industries, Inc. PROflex™, or approved.

2. Outdoor Applications:

a. Description: Woven polyester with vinyl coating, non-porous, double layered, R value of 4.2, temperature range from minus 40 F to 180 F.
b. Manufacturers: Duro Dyne Insulflex®, Ductmate Industries, Inc. PROflex™, or approved.

C. Piping:

1. Braided Type for Pipe Sizes 2 Inch and Smaller:

a. Description: Corrugated stainless steel core covered with high tensile stainless steel woven wire braiding, minimum lateral deflection 1/2 inch.
b. Manufacturers: Keflex™ Manufacturing, Microflex, Inc., The Metraflex Company, Mercer Rubber Co., Garlock®, American Boa Inc.

2. Elastomeric Type for Pipe Sizes 2-1/2 Inch and Larger:

a. Description: Multiple plies of Kevlar tire cord fabric and peroxide cured EDPM, both molded and cured in hydraulic rubber presses.
b. Construction: Two sphere cross-section, no steel wire or rings used as pressure reinforcement, floating steel flanges and solid steel rings within raised rubber flange ends to prevent pullout. Minimum rating 150 psi at 250 F. Connections made with flanged twin-spheres pre-extended as recommended by manufacturer to prevent additional elongation under pressure.
c. Control Assemblies: For sizes 8 inch and larger operating at pressures above 100 psi. Assembly with control cables with end fittings isolated from anchoring plates, and 1/2 inch thick neoprene washer bushings designed for maximum of 1,000 psi. Mason Industries ACC.
d. Manufacturers: Mason Industries Safeflex Series.

3. Refer to Section 221123 for pump discharge flexible connectors.

2.7 MISCELLANEOUS PRODUCTS

A. Fiberglass Acoustical Insulation:

1. General: One half inch thick, 3 pounds per cubic foot, density, unfaced fiberglass batts.
2. Manufacturers: Owens Corning, Tremco, or approved.

B. Acoustical Collar: Quarter inch thick closed cell foam.

C. Resilient Sealant:

1. General: Paintable, non-hardening, non-bleeding, non-drying, resilient calk.
2. Manufacturers and Models: USG Sheetrock® Brand Acoustical Sealant, Pecora Corporation Acoustical Sealant BA-98, Gloucester Corporation Phenoseal Surpass Flexible Sealant (clear color only), or approved.

2.8 THRUST RESTRAINTS

A. Description: Spring in series with neoprene pad. Restraint assembly designed to be field adjusted to allow maximum 3/8 inch movement at equipment start and stop. Restraint assembly designed to sustain overload force equal to 5 times design force without failure. Include attachment hardware.

B. Manufacturer and Model: Mason Industries WBI and WBD.

2.9 FACTORY FINISHES

A. Apply manufacturer's standard paint to factory-assembled and tested equipment before shipping.

1. Powder coating on springs and housings.
2. Mechanically galvanized hardware. Hot dipped galvanize metal components where installed outdoors.
3. Baked enamel for metal components where installed indoors.
4. Color-code or otherwise mark vibration isolator devices to indicate capacity range.

PART 3 - EXECUTION

3.1 INSPECTION

A. Description: Verify installation conditions as satisfactory to receive the Work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

3.2 PREPARATION

A. Field Measurements: Field verify locations of new and existing work prior to commencing the Work of this section.

B. Protection: Protect surrounding areas and surfaces to preclude damage from the Work of this section.

3.3 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

A. Description: Install, apply, erect, and perform the Work in accordance with Article “Quality Assurance” provisions, specifications, and manufacturer’s installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

B. Assistance: Vibration isolation supplier shall provide assistance to Contractor to ensure correct installation and adjustment of vibration isolators and seismic restraints.

C. Prior to Startup: Clean foreign matter between base, isolator, equipment, and mounting surfaces. Verify that there are no rigid connections between equipment and building structure that degrade vibration isolation systems specified in this section.

3.4 EQUIPMENT

A. Spring Mounts:

1. Mark vibration isolators to show undeflected height to verify proper isolation after installation. Install isolators for single piece of equipment with approximately equal deflection. Mount equipment level.
2. Coordinate with general contractor and structural engineer to ensure proper mounting attachment points.
3. Install with Type WB-1 isolators.

B. Spring Hanger Rods: Align isolator to clear isolator housing. Install housing as close as possible to structure.

C. Bases:

1. Install floor-mounted bases with 1 inch clearance between floor or housekeeping pad and base.
2. Install concrete inertia bases with minimum 2 inch clearance between floor or housekeeping pad and base. Fill base with 3000 psi concrete conforming to ASTM C 94.
3. Attach curb mounted isolation base and rigid roof curb to roof structure and attach rooftop HVAC unit to curb in accordance with engineer or specialty consultant’s design.

3.5 DUCTWORK

A. Penetrations of Mechanical Room Walls and Floors and Acoustical Walls and Ceilings:

1. Install sheet metal sleeves through walls and gypsum wallboard ceilings covering entire inside perimeter of oversized opening. Size penetration large enough to pack additional fiberglass and acoustical collar between duct or duct insulation and sheet metal sleeve. Trim excess foam and apply continuous bead of resilient sealant around penetration perimeter.
2. Install 16 gage galvanized sheet metal sleeves through floors. Finish with sheet metal dam as specified in Section 230510.
3. Plaster sleeve to the wall, ceiling, and floor to ensure airtight seal.
4. Where ducts penetrate double walls, install separate sleeves cut and fit to each side of wall. Allow no sleeve connection between walls.

B. Medium Pressure Ducts: Isolate within mechanical rooms or for first 50 feet from vibrating equipment, whichever is greater.

C. Duct Clearance: Install vibration-isolated ducts to allow minimum 2 inch gap between top of duct and underside of floor structure above.

D. Vibration Isolator Housing: Install as close as possible structure.

E. Ducts within Shafts: Install without contact with walls. Anchor to building structure at floor only.

3.6 PIPING

A. Equipment Supports: Coordinate piping supports with equipment supports to maintain uniformly efficient isolation, expansion and contraction, without creating excessive stresses at equipment connection or in portion of piping. Adjust vibration isolators after piping systems have been filled and equipment is at operating weight.

B. Penetrations of Walls and Floors in General:

1. Install resilient sealant in annular space between sleeve and pipe as specified in this section.
2. Comply with requirements in Section 230510 for sleeves through walls and floors.
3.

C. Penetrations of Mechanical Room Walls and Floors and Acoustical Walls and Ceilings:

1. Install sheet metal sleeves through walls and gypsum wallboard ceilings covering entire inside perimeter of inch oversized opening. Size penetration large enough to pack additional fiberglass acoustical insulation and acoustical collar between pipe and pipe insulation and sleeve. Trim excess foam and apply continuous bead of resilient sealant around penetration perimeter.
2. Comply with requirements in Section 230510 for sleeves through floors, fire rated walls and floors, and sheet metal dams.
3. Plaster sleeve to wall, ceiling, and floor to ensure airtight seal.
4. Where pipes penetrate double walls, install separate sleeves cut and fit to each side of wall. Allow no sleeve connection between walls.

D. Piping 2 inch and Larger: Isolate within mechanical rooms or for first 50 feet from vibrating equipment, whichever is greater.

E. Vibration Isolator Housing: Install as close as possible to structure.

F. Risers: Isolate at point of contact with floor structure.

3.7 ELECTRICAL CONNECTIONS TO VIBRATION ISOLATED EQUIPMENT

A. Comply with requirements in Section 230513.

B. Do not install conduit clamps or hangers between flexible raceway termination and equipment connection.

C. Recommended minimum flexible raceway length is 6 feet.

3.8 COMMISSIONING

A. Equipment and systems referenced in this section shall be commissioned per Section 230800. The Contractor has specific responsibilities for scheduling, coordination, test development, testing and documentation.

3.9 VIBRATION ISOLATION SCHEDULE

A. Vibration isolator designations are keyed to items specified in this section.

EQUIPMENT	ISOLATOR	STATIC DEFLECTION (INCH)	BASE
FANS			
Air Handling Units with Plenum Plug or Scroll Centrifugal Fan, Floor-Mounted, Internally Isolated	Type S-2 by Mfr.	2.0	Internal by AHU Mfr.
Centrifugal Fans, Cabinet Type, Floor-Mounted, Internally Isolated	Type S-2 by Mfr.	2.0	Internal by Fan Mfr.
Centrifugal Fans, Cabinet Type, Suspended	Type H-1	2.0	By Fan Mfr.
Centrifugal Fans, Scroll Type, Suspended	Type H-1	1.0	Type B-3
Centrifugal Fans, In-Line, Suspended	Type H-1	1.0	Type B-3

EQUIPMENT	ISOLATOR	STATIC DEFLECTION (INCH)	BASE
PUMPS			
Centrifugal, Floor-Mounted with concrete with inertia Base	Type S-2	2.0	Type B-2
Centrifugal, In-Line, Pipe-Mounted	Type H-2	0.2	-
CHILLERS			
Rotary Screw	Type S-2	2.0	By Chiller Mfr. (Type B-3)
CONDENSERS			
Propeller Fan Type	Type IP-1	--	By Cond Mfr.
CONDENSING UNITS	Type IP-1	1.0	By CU Mfr.
PIPING			
Suspended Piping Inside Mechanical Rooms, 2 Inch and Smaller	Type H-2	0.35	--
Suspended Piping Inside Mechanical Rooms, 2-1/2 Inch and Larger	Type H-1	1.0	--
Multiple Suspended Piping Inside Mechanical Rooms	Type H-1	1.0	--
Suspend Piping Outside of Mechanical Rooms	Type H-2	0.35	--
Pipe Risers	Type IP-1 and Type WB-1	--	--
DUCTS			
Suspended Ducts Inside Mechanical Rooms	Type H-1	1.0	--
Multiple Suspended Ducts Inside Mechanical Rooms	Type H-1	1.0	--

EQUIPMENT	ISOLATOR	STATIC DEFLECTION (INCH)	BASE
Suspended Ducts Outside of Mechanical Rooms	Type H-2	0.35	--
Floor-Mounted Ducts Inside Mechanical Rooms	Type IP-1 and Type WB-1	1.0	--

END OF SECTION 230548

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Description: The Work includes seismic restraints for mechanical equipment and distribution systems

B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to the Work in this section.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.

B. Codes and Standards:

1. ASCE 7, Minimum Design Loads For Buildings and other Structures.

1.3 SUBMITTALS

A. Comply with requirements in Division 01 and Section 230500.

B. Product Data: Submit manufacturer’s technical product data for the following:

1. Seismic restraints
2. Miscellaneous supports

C. Shop Drawings:

1. Seismic restraint installations, including calculations.
2. Shop Drawings shall be stamped and signed by a professional engineer licensed in engineering in the state in which the Work is performed.

D. Calculations: Sizing and weight distribution for seismic restraints. Calculations shall be stamped and signed by a professional engineer licensed in engineering in the state in which the Work is performed.

E. Seismically Certified Equipment: Submit testing installation details.

F. Seismic Restraint Details: Detail fabrication and attachment of seismic restraints. Include the following:

1. Anchorage details and indicate quantity, diameter, and depth of penetration of anchors.
2. Overturning force calculations and other design calculations.
3. Seismic brace layouts indicating locations of seismic bracing.
4. Details for seismic restraints and attachment to structure.

5. Additional design information as required by IBC and ASCE 7.

G. Procedures: Submit procedures and installation instructions for setting and adjusting seismic restraints.

H. Final Inspection Report: Seismic restraint manufacturer shall prepare and submit written report documenting final inspection and certifying that seismic restraints are properly installed and adjusted.

1.4 CONTRACTOR RESPONSIBILITY FOR SEISMIC RESTRAINTS

A. General: A single supplier shall furnish seismic restraints, sway braces, and related hardware for the project unless otherwise specified.

B. Responsibility: This supplier shall be responsible for selection and installation supervision of seismic restraints. Prepare engineering drawings and details and submit to the A/E. Perform installation supervision and provide adjustment instructions.

C. Seismic Restraints:

1. Design and select restraint devices for ducts, pipes, and equipment to meet seismic requirements defined in IBC and ASCE 7. Prepare calculations based on coefficients included on the structural drawings. Refer to the structural drawings for allowable methods and loads.

    a. Seismic Design Category.
    b. Component Importance Factor, IP.
    c. Occupancy Category.
    d. Design Spectral Response Acceleration at Short Periods, SDS.
    e. In-Structure Component Amplification Factor, AP.
    f. Component Response Modification Factor, RP.
    g. Mapped Spectral Acceleration for Short Periods, SS.
    h. Site Coefficient, FA.
    i. Site Class.

2. Retain an engineer, specialty consultant, or seismic restraint device manufacturer to design and develop seismic restraint systems and perform calculations based on actual equipment data.
3. Engineer, specialty consultant, or seismic restraint device manufacturer shall coordinate attachments to structure to verify that attachment points on equipment and structure can accept seismic, weight, and other loads imposed. Pay any additional structural engineering services fee.
4. Shop Drawings, details, and calculations shall be stamped and signed by a professional engineer licensed in engineering in the state in which the Work is performed.

1.5 SEISMIC RESTRAINTS, GENERAL

A. Description:

1. Seismic restraint of equipment as indicated in the Contract Documents and as listed in Article “Seismic Restraint Schedule” in this section.
2. Seismic restraint of piping and ducts as indicated in the Contract Documents and listed in Article “Seismic Restraint Schedule” in this section.
3. Provide components or materials not specifically mentioned herein, but necessary for proper seismic control of equipment.

PART 2 - PRODUCTS

2.1 GENERAL

A. Manufacturers: Mason Industries, Inc., Amber/Booth, Kinetics Noise Control, Vibration Mountings and Controls, Vibro-Acoustics®, Korfund Dynamics Corporation, California Dynamics Corp (CalDyn), TOLCO™, or approved. Mason Industries model numbers are listed.

2.2 MISCELLANEOUS SUPPORTS

A. Type WB-1, Neoprene Washers and Bushings:

1. Washer-bushing manufactured of bridge bearing neoprene.
2. Washer-bushing maximum loading not to exceed 1000 psi.
3. Washer-bushing to be used such that direct contact between bolt and equipment is eliminated.
4. Manufacturer and Model: Mason Industries HG.

2.3 SEISMIC RESTRAINTS

A. General:

1. Restraints capable of safely accepting external forces as defined in IBC and applicable state and local codes without failure to maintain mechanical equipment, piping, and duct in captive position.
2. Seismic devices not to interfere with vibration isolators during normal operation.
3. Seismic mounts shall have State of California OPA number verifying maximum certified horizontal and vertical load ratings.

B. Seismic Restraint E-1:

1. Description: Interlocking steel members restrained by shock absorbent rubber materials compounded to bridge-bearing specifications.
2. Construction:

    a. Elastomeric materials replaceable, minimum 1/4 inch thick molded bushing.
    b. Air gap between hard and resilient material of not less than 1/8 inch, nor more than 1/4 inch.

3. Application: Locate and size snubbers to suit application. Furnish sufficient quantity such that restraint load rating will not be exceeded. Minimum of 4 snubbers required.

4. Manufacturer and Model: Mason Industries Z-1225.

C. Seismic Restraint E-2:

1. Description: Pre-stretched galvanized steel cable assembly with swivel end connections using 2 clamping bolts. Vertical rods at seismic brace locations braced with and rod clamp assembly to accept compressive loads.
2. Application: Cables sized to accommodate loads with minimum safety factor of 2.
3. Manufacturer and Model: Mason Industries SCB with SSB rod clamp assembly.

2.4 FACTORY FINISHES

A. Apply manufacturer's standard paint to factory-assembled and tested equipment before shipping.

1. Mechanically galvanized hardware. Hot dipped galvanize metal components where installed outdoors.
2. Baked enamel for metal components where installed indoors.

PART 3 - EXECUTION

3.1 INSPECTION

A. Description: Verify installation conditions as satisfactory to receive the Work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

3.2 PREPARATION

A. Field Measurements: Field verify locations of new and existing work prior to commencing the Work of this section.

B. Protection: Protect surrounding areas and surfaces to preclude damage from the Work of this section.

3.3 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

A. Description: Install, apply, erect, and perform the Work in accordance with Article "Quality Assurance" provisions, specifications, and manufacturer's installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

B. Assistance: Seismic restraint supplier shall provide assistance to Contractor to ensure correct installation and adjustment of seismic restraints.

3.4 EQUIPMENT, PIPING, AND DUCT SEISMIC RESTRAINTS

A. General: Comply with requirements in IBC and ASCE 7 unless otherwise indicated in the Contract Documents.

B. Coordination: Coordinate with submittals and Shop Drawings of mechanical equipment such as pumps, air handling units, fans, and similar items. Coordinate with general contractor and structural engineer to ensure correct mounting attachment points.

C. Vibration-Isolated Equipment, Piping, and Ducts:

1. Install seismic restraints with factory set clearances. Install seismic restraint to avoid short circuiting of vibration isolators.
2. Isolate bolts from direct contact with structure with Type WB-1 isolators.

3.5 COMMISSIONING

A. Equipment and systems referenced in this section shall be commissioned per Section 230800. The Contractor has specific responsibilities for scheduling, coordination, test development, testing and documentation.

3.6 SEISMIC RESTRAINT SCHEDULE

A. Seismic restraint designations are keyed to items specified in this section.

EQUIPMENT	SEISMIC RESTRAINT
FANS	
Air Handling Units with Plenum Plug or Scroll Centrifugal Fan, Floor-Mounted, Internally Isolated	Internal: Housed Seismic Restraint Spring Type S-2 per Section 230548
Centrifugal Fans, Cabinet Type, Floor-Mounted, Internally Isolated	Internal: Housed Seismic Restraint Spring Type S-2 per Section 230548
Centrifugal Fans, Cabinet Type, Suspended	Type E-2
Centrifugal Fans, Cabinet Type, Floor-Mounted, Externally Isolated	Housed Seismic Restraint Spring Type S-2 per Section 230548
Centrifugal Fans, Scroll Type, Suspended	Type E-2
Centrifugal Fans, In-Line, Suspended	Type E-2
PUMPS	
Centrifugal, Floor-Mounted with Integral Base	Housed Seismic Restraint Spring Type S-2 per Section 230548
Centrifugal, In-Line, Pipe-Mounted	Type E-2
CHILLERS	
Rotary Screw	Type E-1

EQUIPMENT	SEISMIC RESTRAINT
PIPING	
Suspended Piping Inside Mechanical Rooms, 2 Inch and Smaller	IBC
Suspended Piping Inside Mechanical Rooms, 2-1/2 Inch and Larger	IBC
Multiple Suspended Piping Inside Mechanical Rooms	IBC
Floor-Mounted Piping Inside Mechanical Rooms	IBC
Suspend Piping Outside of Mechanical Rooms	IBC
Pipe Risers	IBC
DUCTS	
Suspended Ducts Inside Mechanical Rooms	IBC
Multiple Suspended Ducts Inside Mechanical Rooms	IBC
Suspended Ducts Outside of Mechanical Rooms	IBC
Floor-Mounted Ducts Inside Mechanical Rooms	IBC

END OF SECTION 230550

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Description: The Work includes testing, adjusting, and balancing (TAB) of mechanical systems.

B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to the Work in this section.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.

B. Codes and Standards:

1. AABC, National Standards for Total Systems Balance.
2. ASHRAE 111, Practices for Measurement, Testing, Adjusting, and Balancing of Building Heating, Ventilation, Air--Conditioning and Refrigeration Systems.
3. ANSI S12.60: American National Standard Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools, Part 1: Permanent Schools.
4. NEEB, Procedural Standards for Testing Adjusting and Balancing of Environmental Systems.
5. UL 873, Standard for Temperature – Indicating and Temperature--Regulating Equipment.

C. TAB Subcontractor:

1. General: TAB work performed by independent subcontractor, not affiliated with the Contractor.
2. Qualifications: Certified by National Environmental Balancing Bureau (NEBB) or Associated Air Balance Council (AABC).
3. Experience: Minimum 5 years on projects of similar scope and complexity.
4. TAB Subcontractors: National Indoor Air Care Corporation, AIRTEST Co. Inc., American Air Measurement or Tac Systems. No substitutions.
5. Obtain associated Product Data and Shop Drawings required to determine design--to--actual operating data (coil pressure drops, fan curves and similar data).

1.3 SUBMITTALS

A. General: Comply with requirements in Division 01 and Section 230500.

B. Preliminary Data: Submit the following within 30 days after award of contract:

1. Name of TAB subcontractor.
2. Individual qualifications of persons responsible for supervising and performing the work of this project.

3. TAB agenda listing methods and procedures, and including blank forms applicable to this project. Include blank system readiness checklists for air systems, hydronic systems, and controls. Include sample field reports and corrective action log.
4. List of projects completed by TAB subcontractor of similar size, scope and equipment. Include name of the Contractor and the Owner contacts.
5. List of test instruments.
6. System flow diagrams with pertinent data (flow, pressure, velocity design) for each system to be balanced.
7. Proposed final report table of contents.
8. Sample executive summary that will be included in final report.

C. Pre--Balance System Check--Out Report: Prior to commencement of TAB work, Contractor shall confirm in writing to TAB subcontractor, with copies of notice to the A/E and the Owner, that equipment and system check--out has been performed as described in Article “Work by Contractor”.

D. Balancing Report:

1. Provide complete balancing report in accordance with NEBB or AABC requirements, including the following:

    a. System flow diagrams and floor plans.
    b. Pump curves.
    c. Fan curves.
    d. Manufacturers’ start--up and test data.
    e. Field start--up and test reports prepared by system and equipment installers.
    f. List of test instruments and dates of last calibrated.
    g. Other information relative to equipment performance, but do not include approved Shop Drawings and Product Data.

2. General Report Data: In addition to the form titles and entries, include the following data in the final report, as applicable:

    a. Title page.
    b. Name and address of testing, adjusting, and balancing Agent.
    c. Project name.
    d. Project location.
    e. Architect’s name and address.
    f. Engineer’s name and address.
    g. Contractor’s name and address.
    h. Report date.
    i. Signature of testing, adjusting, and balancing supervisor who certifies report.
    j. Summary of contents, including the following:

        1) Design versus final performance.
        2) Notable characteristics of systems.
        3) Description of system operation sequence if it varies from the Contract Documents.

    k. Nomenclature sheets for each item of equipment.
    l. Data for terminal units, including manufacturer, type size, and fittings.
    m. Test conditions for fans and pump performance forms, including the following:

1) Settings for outdoor, return, and exhaust air dampers.
2) Conditions of filters.
3) Cooling coil, wet-- and dry--bulb conditions.
4) Fan drive settings, including settings and percentage of maximum pitch diameter.
5) Settings for supply air static pressure controller.
6) Other system operating conditions that affect performance.

1.4 JOB CONDITIONS

A. Make 3 site visits to assess system readiness prior to start of TAB work.

B. Do not proceed with TAB work until work has been completed and is operable. Ensure that there is no latent residual work still to be completed.

C. Partial Owner Occupancy: The Owner may occupy completed areas of building before Substantial Completion. Cooperate with the Owner during TAB operations to minimize conflicts with the Owner's operations.

1.5 COORDINATION

A. Attend and participate in 10 field coordination meetings, contributing air and water balancing requirements to field coordination documents. Arrange with the Contractor to have representatives of mechanical, electrical, sheet metal, and control subcontractors be present at each meeting.

B. Coordinate efforts of factory--authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.

C. Give 7 days' advance notice to parties needing to be present or to participate with tests and to the A/E for each test. Include scheduled test dates and times.

D. Perform TAB work after leakage and pressure tests on air and water distribution systems have been satisfactorily completed. Refer to Section 233100 for allowable duct leakage requirements.

1.6 SEQUENCING/SCHEDULING

A. General: Phase in properly with the A/E reviewed/accepted Construction Schedule with respect to flooring work (carpet laying and tiling), ceiling installation, final building cleaning, fire alarm system testing, and similar activities that would affect TAB work.

PART 2 - PRODUCTS

2.1 INSTRUMENTS

A. General: Furnish materials and equipment necessary to measure system capacities, electrical voltage and current, fan speeds, static pressures, air velocities, water pressure drops, sound levels and other readings necessary to evaluate system performance and adjust quantities to those indicated. Materials and equipment shall remain in possession of TAB subcontractor after project is completed.

B. Instrumentation: Use in accordance with manufacturer's instructions.

C. Calibration: At least every 12 months.

PART 3 - EXECUTION

3.1 INSPECTION

A. Description: Verify installation conditions as satisfactory to receive the Work of this section. Beginning work constitutes acceptance of conditions as satisfactory.

3.2 PREPARATION

A. Field Measurements: Field verify locations of new and existing work prior to commencing the Work of this section.

B. Protection: Protect surrounding areas and surfaces to preclude damage from the Work of this section.

3.3 PERFORMANCE

A. Description: Perform the work in accordance with Article "Quality Assurance" provisions, specifications, and manufacturer's installation instructions and directions. Where these may be in conflict, more stringent requirements govern.

3.4 SYSTEM READINESS PRIOR TO TAB WORK

A. System Performance: The Contractor is responsible for performance of equipment and systems. Do not assume that supplier will ship equipment adjusted to meet project requirements.

B. Equipment Operation:

1. Check equipment for proper operation as soon as electrical power is available. Perform adjustments required for proper operation.

2. Report malfunctions to manufacturer and take corrective action immediately to prevent delay of work.
3. Check--out equipment for electrical problems, check rotation of motors, read voltage and current in each leg of each motor, heater, and similar devices, and check readings against nameplate. Lubricate per manufacturer's recommendations.
4. Before testing, adjusting, and balancing commences, operate (test run) equipment for minimum 1 week.
5. Complete pre--functional equipment and systems checklists specified in Section 230800 and submit signed and dated copies to the Owner, the A/E, and TAB subcontractor.

C. Air Distribution System Inspection: Check out air distribution system to ensure that fans are connected to ducts, that outlets are connected to branch ducts, and that a volume damper exists for each air device (supply, return, and exhaust) and is in the wide--open position. Verify installation and function of branch volume dampers.

D. Hydronic Systems: Check out hydronic systems to ensure that piping has been completed, flushed, and filled. Ensure that properly operating air vents are installed at system high points and that those systems are free of air. Ensure that temperature/pressure test ports are installed across system components including but not limited to, pumps, coils, heat exchangers, or similar items and as required for balancing.

E. Controls Operation: Check out and calibrate control components under equipment and system operation service. These components include, but are not limited to, thermostats and temperature sensors to ensure they are connected to appropriate devices, respond to temperature changes, and perform correct action compatible with controlled devices.

F. Strainers and Filters: After equipment and system check--out work has been completed, and prior to commencement of TAB work, perform the following:

1. Clean strainers in hydronic systems.
2. Remove air filters in air distribution equipment and systems and install new filters as specified in Section 234100.

G. Access: Provide scaffolds, staging, and accessories required to allow TAB subcontractor to gain access to equipment, dampers, valves, and other devices located beyond range of 6 foot stepladder.

H. Fan Adjustment and Drive Changes: Perform necessary drive changes as directed by TAB subcontractor, including furnishing required sheaves and belts. Coordinate with Sections 233400, 235500, and 238100.

I. Pump Impeller Trim: For constant volume systems that use pump discharge valves to reduce pump head by more than 10 percent of design to achieve balanced conditions, remove impeller and based on TAB subcontractor requirements for proper impeller diameter, arrange for impeller trim and statically and dynamically balance after trim by the pump manufacturer or authorized representative, reinstall, and replace nameplate tag that reflects the as--built condition.

J. Instrument Test Holes: Install at locations as directed by TAB subcontractor. Refer to Section 233100.

K. Cleaning: Clean equipment and devices after check--out and test run period prior to TAB work.

3.5 WORK BY TAB SUBCONTRACTOR

A. General: Adjust quantities to within percent of design values as follows:

1.	Supply air outlets and fans	0 to plus 10 percent
2.	Return and exhaust fans	0 to plus 10 percent
3.	Return and exhaust air inlets	0 to minus 10 percent
4.	Heating and cooling flows	0 to minus 10 percent

B. For rooms and air devices that are identified to maintain negative pressure relationships to adjacent rooms, adjust air quantities to within the percent of design values as follows but no less than the air quantities per WAC 246-320-525 requirements:

1.	Supply air outlets	0 to minus 10 percent
2.	Return and exhaust air inlets	0 to minus 10 percent

C. Systems: Include, but are not limited to, the following:

1. Supply air systems.
2. Return air systems.
3. Exhaust air systems.
4. Ventilation systems.
5. Chilled water systems.
6. Heating water systems.
7. Auxiliary heating and cooling systems.
8. Domestic hot water circulating systems.

D. Existing Air Handling Systems: Perform TAB for those portions of existing air handling systems that are modified as part of this project. TAB work shall include same activities as for new systems.

E. Readings:

1. General: Take readings including, but not limited to, the following:

    a. Air Quantities:

        1) Supply, return, exhaust, and outdoor air at each terminal.
        2) Perform duct transverse at branch mains conveying minimum 2000 cfm and for system total air.

    b. Air Temperatures:

        1) Outdoor air at equipment.
        2) Return air at equipment.
        3) Supply air leaving equipment.
        4) Mixture of outdoor and return air before entering cooling and heating coils and other heat transfer equipment.

    c. Air Handling Equipment:

        1) Fan RPM

2) System static pressure and fan suction and discharge pressures.
3) Clean filter pressure drop.
4) Heating and cooling coil air pressure drop.
5) Sheave make, sizes, and shaft size.
6) Number of belts, make, and size.

d. Hydronic Pressures and Flows:

1) Water pressure at inlet and outlet of pumps as close to pump impeller as possible.
2) Water pressure drop across suction strainer of pumps.
3) Water pressure drop across chillers, boilers, and other energy--producing equipment.
4) Water pressure drop across coils, heating elements, heat exchangers, and other energy--using equipment.
5) Flow--measuring devices in system.

e. Hydronic Temperatures:

1) Inlet and outlet of chillers, boilers, and other energy--producing equipment.
2) Inlet and outlet of coils, heating elements, heat exchangers, and other energy--using equipment.

f. Electrical:

1) Measured voltage and amps on each phase of each motor (for example, pumps and fans) while equipment is under maximum normal load.
2) The nameplate voltage and current for each motor.

2. Compare pressure drop readings to manufacturers' rating sheets to determine actual flow through equipment.
3. Explain readings out of range.

F. System Difficulties: Obtain readings on each unit or piece of equipment as early as possible such that discrepancies can be resolved before anticipated close of job.

G. Static Pressure Setpoint for Variable Air Volume (VAV) Air Handling Systems:

1. Adjust fan speeds and system static pressure setpoint, as necessary, to attain full cooling airflow rate throughout system with variable frequency drive operating near lowest frequency. Simulate dirty filter pressure drop and record readings. Ensure full load amperages at fan motors are not exceeded. Cooling coil surface shall be wet during full--cooling balancing. Record system operating static pressure setpoint.
2. Set system static pressure setpoint to lowest pressure that will maintain sufficient inlet pressure at hydraulically most distant VAV unit. Record number of "hydraulically most distant unit". Confirm sufficient static pressure at most distant unit by reading airflow delivered from that unit. Record duct static pressure at the "hydraulically most distant unit" that corresponds with supply air fan duct static pressure setpoint in both minimum and 100 percent outdoor air modes.

H. Pressure Setpoint for Variable Speed Pumps:

1. Measure pressure differential at most limiting control valve. Ensure pressure is sufficient to maintain proper flow rate. Record final operating characteristics of pump.
2. With limiting ("hydraulically most distant") valve at full flow, adjust pump speed pressure control setpoint to lowest value that will maintain minimum differential pressure required at limiting valve. Record number of the equipment associated with the limiting valve. Record differential static pressure at the limiting valve that corresponds with pump speed pressure setpoint.

I. Fan Adjustment and Drive Changes:

1. Inform the Contractor as to which sheaves and belts need to be changed. Take final readings and make required sheave adjustments.
2. Verify that fans with electronically commutated motors (ECMs) have been adjusted at the equipment factory as required by Section 233300. Make further adjustments to achieve design air flow.

J. Outdoor Air/Economizer Cycles:

1. After supply air outlets and return air inlets are in balance and air quantities correct, adjust outdoor air damper to minimum air quantity indicated on the Drawings for each system. If not indicated, contact A/E for minimum outdoor air quantities.
2. Adjust using temperature averaging method when outside air temperature is 15 F higher or lower than return air temperature.
3. If economizer control is specified, check for setting of controls and for operation of dampers (outdoor air, return air, and relief). Adjust return/relief system to result in a slight positive pressure in building (0.03 to 0.05 inch w.g.) with exhaust fans in operation. Indicate which mode air handling system was in when outlets were balanced (minimum and 100 percent outdoor air modes).
4. Prepare outdoor air summary sheet indicating minimum outdoor air quantity for each system as designed and as tested. Include percent of minimum outdoor air.

K. Inspection and Recheck:

1. Upon request, recheck random selections of up to 10 percent of readings recorded in Balancing Report in presence of the Owner's representative.
2. Balancing Report will be rejected if more than 20 percent of rechecked readings deviate more than 10 percent of recorded readings in report. In this event, perform complete rebalancing of system.

L. Marking of Adjustments:

1. After final inspection and recheck, permanently mark dampers, valves, and other adjustment devices to allow adjustment to be restored if disturbed in the future.
2. If recheck requires re--balancing, eradicate previous markings and re--mark.
3. Set and lock valve memory stops.

M. Final Field Activities: Prior to final acceptance, perform the following:

1. Leave systems in proper working operation.
2. Reinstall belt guards.
3. Close access doors.
4. Reinstall covers on electrical J--boxes and switch boxes.

5. Restore thermostat settings to original settings.
6. Reinstall insulation over flow meters, balancing valves, and pumps.
7. Patch holes in insulation, ductwork and equipment housing, which have been cut or drilled for TAB work in manner recommended by insulation subcontractor.
8. Adjust vanes on adjustable grilles and diffusers and modular type diffusers to eliminate drafts and to prevent stratification for air circulation acceptable to the A/E.
9. Reinstall ceiling tiles.

N. Sound Level Readings:

1. Include dBA and octave band dB readings of each room after final balance in final report. Take readings with HVAC systems in operation. List frequencies or include printout of area in report for dB readings. Translate readings to NC level. Include NC chart for each roomList readings for classrooms and any areas of learning/teaching including commons, gym, performing art center, and concert hall. Random samples of 20 percent of offices within administration area are acceptable. Restrooms, storage rooms, and mechanical rooms do not need to be measured.
2. For each space type tested, select a measurement location that has the greatest sound level.

3.6 ADDITIONAL TESTS

A. Within 90 days of completing TAB work, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial testing, adjusting, and balancing procedures were not performed during near--peak summer and winter conditions, perform additional inspections, testing, and adjusting during near--peak summer and winter conditions.

3.7 COMMISSIONING

A. Equipment and systems referenced in this Section shall be commissioned per Section 230800. The Contractor and TAB subcontractor have specific responsibilities for scheduling, coordination, test development, testing and documentation.

B. Submit preliminary report of balance data to the Commissioning Authority and the A/E. This documentation shall be requirement for final functional performance testing.

C. Participate in selected (maximum of 6) commissioning meetings for coordination and support of commissioning process.

END OF SECTION 230593

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Description: The Work includes insulation for plumbing and HVAC piping, ductwork, and equipment.

B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to the Work in this section.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.

B. Codes and Standards:

1. Applicable energy code.
2. ASHRAE 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings.
3. ASTM C 533, Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.
4. ASTM C 534, Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
5. ASTM C 547, Standard Specification for Mineral Fiber Pipe Insulation.
6. ASTM C 552, Standard Specification for Cellular Glass Thermal Insulation.
7. ASTM C 553, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
8. ASTM C 1136, Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
9. ASTM C 1139, Standard Specification for Fibrous Glass Thermal Insulation and Sound Absorbing Blanket and Board for Military Applications.
10. ASTM C 1290, Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts.
11. ASTM C 1729, Standard Specification for Aluminum Jacketing for Insulation.
12. ASTM C 1767, Standard Specification for Stainless Steel Jacketing for Insulation.
13. ASTM D 1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Components.
14. ASTM D 5590, Standard Test Methods for Determining the Resistance of Paint Films and Related Coatings to Fungal Defacement by Accelerated Four-Week Agar Plate Assay.
15. ASTM E 84, Standard Test Method for Surface Burning Characteristics of Building Materials.
16. ASTM E 96, Standard Test Methods for Water Vapor Transmission of Materials.
17. ASTM E 814, Standard Test Method for Fire Tests of Penetration Firestop Systems.
18. NFPA 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems.
19. National Commercial & Industrial Insulation Standards (NCIIS)
20. UL 723, Tests for Surface Burning Characteristics of Building Materials.

C. Insulation Subcontractor's Qualifications: Specialty contractor normally engaged using products from manufacturers specified in this section.

D. GREENGUARD Environmental Institute™ Certification: Include for pipe insulation and duct wrap and rigid board duct insulation.

1.3 SUBMITTALS

A. Comply with requirements in Division 01 and Section 230500.

B. Product Data: Submit manufacturer's technical product data, installation data, and certifications for the following:

1. Piping system insulation
2. Duct system insulation
3. Equipment insulation
4. Inserts
5. Insulation shields
6. Jacketing

1.4 DEFINITIONS AND ABBREVIATIONS

A. Definitions:

1. "Exposed" and "Concealed" are defined in Section 230500.
2. "Cold Plumbing Piping" includes the following down to 0 F:

a. Domestic cold water.
b. Non-potable cold water.
c. Horizontal rainleaders and overflow rainleaders.
d. Make-up water.
e. Indirect condensate drain.

3. "Cold HVAC Piping" includes the following:

a. Chilled water supply and return.
b. Refrigerant suction.
c. Refrigerant liquid.

4. "Hot Plumbing Piping" includes the following:

a. Hot water and hot water circulating (all temperatures).
b. Non-potable hot water.

5. "Hot HVAC Piping" includes the following up to 850 F:

a. Heating water supply and return.
b. Refrigerant discharge (hot gas).

6. “Conditioned Air Duct” is duct for air that is heated, cooled, or humidified, and includes supply, return, and outdoor air intake and combustion air ducts.
7. “Duct Not Within Conditioned Space” is duct for air that is located outside the building envelope or in unconditioned space.
8. “Duct Within Conditioned Space” is duct for air that is located inside the building envelope including outdoor air duct and relief duct on the building side of motor operated and backdraft dampers.
9. “Duct Within Conditioned Space Functioning as part of Building Envelope” is duct for air that is located in the building but on the outdoor side of motor operated and backdraft dampers.
10. “Equipment” includes the following:

    a. Cold Equipment:

        1) Chiller evaporators if not factory insulated.
        2) Expansion tanks.
        3) Air separators.
        4) Pipe unions.
        5) Strainers.
        6) Expansion joints.
        7) Roof drain and overflow roof drain bodies.

    b. Hot Equipment:

        1) Hot water storage tanks.
        2) Domestic water heaters.
        3) Heating water pump housings.
        4) Expansion tanks.
        5) Air separators.
        6) Pipe unions.
        7) Strainers.
        8) Expansion joints.

11. “Piping” includes pipe, fittings, valves, and appurtenances.

B. Abbreviations:

1. ASJ: All-service jacket.
2. FSK: Foil-scrim-kraft jacket.
3. PCF: Pound per cubic foot density.
4. Perm: Water vapor transmission rate (permeability).
5. SSL: Self-sealing lap.

1.5 SURFACE BURNING CHARACTERISTICS

A. Provide composite or component ratings per ASTM E 84 and UL 723 with flame spread rating not greater than 25 and smoke developed rating not greater than 50.

B. Composite includes insulation, jacketing, and adhesive used to secure jacketing or facing.

C. Components include PVC jacketing and fittings, adhesive, coating, mastic, cement, tape, and cloth.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Fiberglass Pipe Insulation: ASTM C 547, Type 1. Include factory applied ASJ/SSL. K-value not greater than 0.23 at 75 F mean temperature.

B. Fiberglass Pipe Fitting Insulation: Thermal blanket, ASTM C 553, Type I or II. K-value not greater than 0.26 at 75 F mean temperature.

C. EDPM Elastomeric Pipe Insulation: ASTM C 534, Type I for tubular materials, Grade 1. K-value not greater than 0.27 at 75 F mean temperature. Water vapor transmission not greater than 0.05.

D. Calcium Silicate Pipe Insulation: ASTM C 533, Type 1. Include factory stucco embossed jacket. K-value not greater than 0.68 at 700 F mean temperature. 14.5 PCF.

E. Cellular Glass Pipe Insulation: ASTM C 552, Type II. K-value not greater than 0.29 at 75 F mean temperature. 7.5 PCF.

F. Fiberglass Duct Insulation: ASTM C 553, Type I, II, or III, ASTM C 1290, ASTM C 1139, Type III (faced), ASTM E 84, and ASTM C 1136, Type II for FSK jacket. 0.75 PCF for duct wrap and 3 PCF for concealed and 6 PCF for exposed rigid board.

G. EDPM Elastomeric Duct Insulation: ASTM C 534, Type II for sheet materials, Grade 1. K-value not greater than 0.245 at 75 F mean temperature. Water vapor transmission not greater than 0.03.

H. Staples, Bands, and Wires: As recommended by insulation manufacturer for applications indicated.

I. Adhesives, Sealants, Coatings, Mastics, and Protective Finishes:

1. Joint Sealants for Below-Ambient Cellular Glass Insulation: Childers CP-70 Chil-Joint® and CP-76 Chil-Byl®, Foster® 30-45™ N Foamseal® and 95-50™ Flextra®, Pittsburgh Corning Corporation Pittseal® 444N or approved.
2. FSK and Metal Jacket Flashing Sealants: Childers CP-76 Chil-Byl®, Foster® 95-44™ Elastolar®, Pittsburgh Corning Corporation Pittseal® 444N or approved.
3. Vapor Barrier Coatings: Water based suitable for indoor use on below-ambient services. ASTM D 5590 with 0 growth rating. Water vapor permeance per ASTM F 1249, 0.08 perms or less at 45 mil dry. White color. Foster® 30-80AF™ Vapor-Safe® or approved
4. Weather Barrier Breather Mastic: Water based suitable for indoor and outdoor use on above-ambient services. Water vapor permeance: ASTM F 1249, 1.8 perms at 0.0625 inch dry film thickness. White color. Childers CP-10 Ak-Cryl™ and CP-11 Ak-Cryl™, Foster® 46-50™ Weatherite, Vimasco WC-1 and WC-5, or approved.

5. Elastomeric Insulation Coating: Water based polyacrylate copolymer emulsion finish. Armaflex WB, K-Flex® 374, Aeroflex USA, Inc, Aerocoat™, or approved.
6. Elastomeric Insulation Adhesive: Foster® 85-75™Drion®, Armacell® 520, Aeroflex USA, Inc. Aeroseal,™ or approved.
7. Lagging Adhesive: For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24). Foster® 30-36 AF™ Sealfas® or approved.

2.2 MANUFACTURERS

A. Fiberglass Pipe and Duct Insulation: CertainTeed, Knauf Insulation Earthwool®, 1000º, Manson Insulation ALLEY-K™, Johns Manville, Owens-Corning, or approved.

B. EPDM Elastomeric Pipe and Duct Insulation: Aeroflex USA Inc., Aerocel-SSPT (Stay-Seal® with Protape® and Cel-Link II®), K-Flex® USA, Armacell®, or approved.

C. Calcium Silicate Insulation: Industrial Insulation Group, LLC Thermo-12 Gold®.

D. Cellular Glass Insulation: Pittsburg Corning Foamglas® or approved.

E. Adhesives, Sealants, Coatings, Mastics, and Protective Finishes: Foster, Childers, Pittsburgh Corning, Vimasco, Armacell®, K-Flex®, Aeroflex USA, Inc., or approved.

2.3 PIPING SYSTEM INSULATION

A. Insulation materials and thicknesses shall meet or exceed insulation requirements of applicable energy code. Where insulation thickness indicated on the Drawings or specified in this section is thicker than that listed in applicable energy code, use thicker values. Refer to Article “Extent of Piping Insulation” in this section.

B. Insulate cold plumbing and cold HVAC piping with fiberglass or elastomeric insulation.

C. Insulate cold plumbing and cold HVAC piping at wall supports with elastomeric, same thickness as adjacent fiberglass or elastomeric pipe insulation. Aerofix-U™ Insulating Pipe Hanger Support or approved. At Contractor’s option, insulated pipe hangers specified in Section 232116 acceptable.

D. Include factory applied ASJ/SSL on fiberglass or elastomeric pipe insulation. For below ambient piping, seal seams with vapor barrier coating.

E. Fittings, Flanges, and Grooved Joint Couplings:

1. General: Thickness equal to adjacent pipe insulation.
2. Indoor: Preformed fiberglass or elastomeric insulation, mitered sections of pipe insulation, or fiberglass or elastomeric insulation blanket. For below ambient piping, coat insulated elbows and fittings with vapor barrier coating and reinforcing mesh. Finish with one-piece premolded PVC fitting covers.
3. Outdoor Jacketing: Preformed fiberglass or elastomeric insulation, mitered sections of pipe insulation, or contoured fiberglass or elastomeric insulation inserts. On below ambient piping, coat insulated elbows and fittings with vapor barrier coating and

reinforcing mesh. Finish with preformed outdoor grade ultraviolet-resistant PVC jacket identical in composition to adjacent jacketing.

F. Valves, Specialties, and Pumps:

1. Removable pad type flexible blanket sandwich section of fiberglass, equal thickness as adjacent insulation, enclosed in silicone impregnated glass cloth cover machine sewed at ends.
2. Include stainless steel “D” ring straps with Velcro tabs or full length Velcro at longitudinal seam.
3. Length of blanket sufficient for removal of bolts without damaging adjacent insulation.
4. Manufacturer: Shannon Enterprises INSULTECH® or approved.

G. Adhesives, Mastics, and Cements: Compatible with piping insulation.

2.4 DUCT SYSTEM INSULATION

A. Insulation materials and thicknesses shall meet or exceed insulation requirements of the applicable energy code. Where insulation thickness specified is larger than those listed in the applicable energy code, use the larger values. Refer to Article “Extent of Duct Insulation” in this section.

B. Duct Wrap: Flexible fiberglass duct wrap or elastomeric insulation with factory applied FSK facing (vapor barrier) consisting of aluminum foil reinforced with fiberglass scrim laminated meeting ASTM E 84 and UL 723. Finish duct insulation seams with tape and vapor barrier coating.

C. Rigid Board: ASJ, R-value not less than 4.2.

D. Adhesives, Mastics, Coatings, Sealants, and Cements: As specified in Article “Materials” in this section. Compatible with duct and plenum insulation.

2.5 EQUIPMENT INSULATION

A. Insulate equipment with fiberglass, 2 inch thick. Fiberglass board, maximum 0.02 perm vapor transmission rate. K-value not greater than 0.23 at 75 F mean temperature.

1. Exposed:

a. 6 PCF, ASJ or FSK facing.
b. 6 PCF, ASJ, glass cloth and mastic finish with corner beads.

2. Concealed and Exposed Irregular Surfaces:

a. 3 PCF, ASJ or FSK facing.
b. 3 PCF, ASJ, glass cloth and mastic finish with corner beads.

2.6 JACKETING

A. Metal: 0.016 inch thick aluminum per ASTM C 1729 or 0.10 inch thick Type 316 stainless steel per ASTM C 1767. Include moisture barrier on inner surface.

B. EPDM Elastomeric Insulation: Factory applied, 30 mil thick PVC jacket.

C. Standard Duty Factory Assembly: At Contractor option for metal jacket described above, multi ply, 7 mil thick, flexible, self-adhering assembly as a protective jacket, vapor barrier and weather proof membrane with acrylic adhesive on inside surface and natural aluminum exterior finish. Jacket material with 0.000 water vapor permeance rating per ASTM E 96 Procedure B, and UV resistant. VentureClad Type 1577 CW Foster Vapor-Fas™ 62-05 or approved.

D. Factory Applied Metal Jacket: At Contractor option, fiberglass or elastomeric pipe insulation with factory applied metal jacket for pipe sizes 2 inch and larger acceptable. Knauf Redi-Klad™ or approved.

PART 3 - EXECUTION

3.1 INSPECTION

A. General: Verify installation conditions as satisfactory to receive the Work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

3.2 PREPARATION

A. Field Measurements: Field verify locations of new and existing work prior to commencing the Work of this section.

B. Protection: Protect surrounding areas and surfaces to preclude damage from the Work of this section.

3.3 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

A. General: Install, apply, erect, and perform the Work in accordance with Article “Quality Assurance” provisions, specifications, manufacturer’s installation instructions and directions, and requirements described in NCIIS. Where these may be in conflict, the more stringent requirements govern.

3.4 TIME OF APPLICATION

A. General: Apply insulation only after piping and ducts have been pressure tested and certified by the A/E as ready for insulation. If insulation is applied prior to pressure testing, necessary removals, repairs, and modifications to insulation due to leaks that may occur shall be made at no additional cost to the Owner.

B. Manufacturer's Instructions: Follow with regard to ambient temperature requirements and special techniques.

3.5 EXTENT OF INSULATION

A. Insulate piping, conditioned air ductwork, and equipment, except as indicated in the Contract Documents.

B. Do not Insulate the Following:

1. Piping:

   a. Valve handwheels and operators.
   b. Trap primer piping downstream of trap primers except where buried.
   c. Temperature/pressure test ports (Pete's Plugs).
   d. Tempered water except for systems 100 F and above.
   e. Vertical rainleaders and overflow rainleaders, except for that vertical portion between roof drain bodies and horizontal rainleaders and overflow rainleaders.

2. Ducts:

   a. Transfer, exhaust, and relief ducts except as specified in this section.
   b. Return ducts in suspended ceiling spaces located within building insulation envelope.
   c. Return ducts exposed in conditioned space.
   d. Factory-insulated flexible ducts.
   e. Supply ducts exposed within a space that serves that space only.
   f. Duct flexible connections.

3. Equipment:

   a. Items with factory-applied insulation meeting the requirements of this section.
   b. Nameplates and ASME labels.

C. Ducts Specified to Have Soundlining and Factory Soundlined Ducts: Refer to Section 233100. Need not be insulated unless additional insulation is required to meet thickness requirements of this section.

3.6 INSTALLATION, GENERAL

A. Apply in a workmanlike manner by skilled workmen regularly engaged in this type of work.

B. Apply to clean and dry surfaces.

C. On cold piping and duct surfaces, apply with continuous, unbroken vapor barrier. Vapor seal seams with vapor barrier coating. Insulate and seal supports, anchors, and other projections and penetrations that are secured to cold surfaces with vapor barrier coating. Apply vapor stops or vapor dams at butt joints at every fourth pipe section joint and at each fitting.

D. Install insulated pipe hangers as specified in Section 232116 on all insulated piping systems.

E. Extend surface finishes to protect raw edges, ends, and surfaces of insulation.

F. Install piping and duct insulation continuous through walls, ceilings, and floor openings and sleeves, except where firestop materials are required.

G. Install with joints tightly butted or adhered per manufacturer's requirements.

H. Install insulation to allow access to equipment for inspection and repairs.

I. Bevel and seal insulation around equipment nameplates and ASME labels.

J. Do not allow fiberglass insulation to get wet or absorb moisture. Remove and dispose of wetted and moist fiberglass insulation and replace with new, dry material. Drying out wetted fiberglass insulation not acceptable.

K. Select inside diameter of piping insulation to accommodate thickness of electric heat tracing cable specified in Section 230513.

3.7 PIPING SYSTEM INSULATION

A. PVC Covers for Fittings and Valves: Seal circumferential edges by 2 inch minimum overlap onto adjacent pipe insulation using PVC tape or ASJ/SSL butt strip material.

B. Glass Fabric and Vapor Barrier Finish for Below Ambient, Insulated Fittings and Valves: Lap 2 inch onto adjacent pipe insulation.

C. Cold Piping:

1. Secure fiberglass or elastomeric insulation ends with SSL butt strips, minimum 3 inch wide. Vapor seal ASJ seams with vapor barrier coating. Adhere elastomeric butt joints per manufacturer's requirements.
2. Secure joints and exposed ends at fittings, valves, and equipment with vapor barrier coating. Ensure that vapor barrier for insulation system is continuous from piping to exterior of system to prevent moisture migration into insulation envelope.
3. Vapor seal joint connections to insulated pipe hangers specified in Section 232116.
4. Install insulated pipe hangers as specified in Section 232116 between wall support clamp and pipe or use insulated pipe hanger. Vapor seal joint connections to adjacent fiberglass or elastomeric insulation.
5. Install insulation on waste conveying condensate pipes which receive condensate from ice machines, condensate drain pans, and similar applications from floor drains, floor sinks, floor receptors, and roof receptors. Insulate from underside of drain to a point 5 feet downstream of trap or to connection to another waste pipe.

D. Hot Piping:

1. Secure fiberglass or elastomeric ends with ASJ/SSL butt strips, minimum 3 inch wide. Secure ASJ laps and butt strips with suitable lap adhesive.
2. Secure PVC covers with tacks, PVC tape, or solvent type PVC adhesive.

E. Buried Piping Insulation:

1. General: Stagger and seal seams and joints for specified thickness.
2. Bedding: Install in 4 inch thick sand bed.

3.8 DUCT SYSTEM INSULATION

A. Cut insulation slightly longer than circumference of duct to insure full thickness at corners. Apply insulation with edges tightly stitched with staples. Tape stitched seam with 3 inch wide pressure sensitive aluminum foil or FSK tape or seal joints with 2 coats of vapor barrier mastic reinforced with one layer of open weave glass fabric.

B. Secure insulation to bottom of rectangular and square ducts 18 inch and wider with welded pins and speed clips on 18 inch centers. Cut off protruding ends of the pins flush after speed clips have been installed. Seal vapor barrier facing where pins have pierced through with tape of same material by applying vapor barrier adhesive to both surfaces as recommended by manufacturer.

C. Install fiberglass duct wrap with maximum 25 percent compression.

D. Insulate exhaust ducts from exterior louver, roof cap, or similar termination, to a point 10’-0” into building or to backdraft or motor operated damper, whichever distance is less. Remaining exhaust ducts uninsulated.

E. Seal other joints and penetrations of vapor barrier facing with 3 inch wide pressure sensitive aluminum foil or FSK tape and vapor barrier coating. Seal cuts and tears with strips of aluminum foil or FSK tape and apply vapor barrier coating.

F. Where louvers are blanked off, insulate blank off as specified for outside air ducts.

G. Rectangular transfer ducts will be fabricated with 1 layer of soundlining as specified in Section 233100.

3.9 EQUIPMENT INSULATION

A. General:

1. Form or fabricate insulation to fit equipment. Groove or score as required to closely conform to round surfaces. Bevel edges and tightly butt and stagger joints.
2. Apply smooth coat of insulating cement over irregular surfaces.
3. Install removable insulation on heads of heat exchangers and other equipment requiring access for maintenance, repair, and cleaning. Fabricate removable section joints using a male-female shiplap type joint. Finish entire surface of removable section as specified in this section.

B. Indoor to 450 F:

1. Secure with adhesive, fasteners, or bands. Locate fasteners maximum 3 inch from edges and spaced maximum 12 inch on center.
2. Overlap vapor barriers minimum of 2 inch at seams and seal with pressure sensitive tape or weather barrier breather mastic.

3. Cover penetrations, facing damage, and mechanical fasteners with minimum 2 inch overlap of tape or weather barrier breather mastic.
4. When glass cloth and mastic is used, stretch glass cloth snugly to form smooth finished surface.

3.10 EXTENT OF EQUIPMENT INSULATION

A. Insulate the following cold plumbing and cold HVAC equipment:

1. Chiller evaporators if not factory insulated.
2. Chilled water pump housings.
3. Roof drain and overflow roof drain bodies.
4. Air separators.
5. Pipe unions.
6. Strainers.
7. Expansion joints.
8. Valves.
9. Flanged joints.
10. Pumps and air separators same as for hot and cold HVAC equipment. Insulate base mounted supports from bottom of headers to thermal breaks.
11. Water meters.

B. Insulate the following hot plumbing and hot HVAC equipment:

1. Heating water pump housings.
2. Air separators.
3. Pipe unions.
4. Strainers.
5. Expansion joints.
6. Valves.
7. Flanged joints.

3.11 JACKETING, FIELD APPLIED

A. Jacketing Application: Install over insulation in the following locations:

1. Exposed piping and ducts in finished spaces and normally occupied areas. Locate jacket seams in least visible locations.
2. Below 6 feet above finished floor in mechanical rooms.
3. Piping and ducts located outdoors.
4. Over calcium silicate insulation.

B. Metal:

1. Provide 2 inch minimum overlap joints to hold insulation and jacketing in place.
2. Seal joints with metal jacketing sealant continuously along longitudinal seams, applied to shed water.
3. Seal circumferential joints with metal jacketing sealant. Overlap adjacent jacketing minimum 2 inch. Secure jacketing and butt strips with 1/2 inch bands and seals.
4. Install longitudinal seams for pipes to be out-of-sight where pipes are exposed.

C. Factory Assembly: Apply to pipe and duct insulation per manufacturer's installation instructions.

3.12 COMMISSIONING

A. Equipment and systems referenced in this section shall be commissioned per Section 230800. The Contractor has specific responsibilities for scheduling, coordination, test development, testing and documentation.

3.13 EXTENT OF PIPE INSULATION

A. Insulate piping in the Contract Documents per the following table:

TYPE OF PIPE	INSTALLATION LOCATION	INSULATION TYPE	PIPE SIZE (INCHES)	INSULATION THICKNESS (INCHES)	NOTES
Cold Plumbing Piping	Inside Building Envelope	Fiberglass or Elastomeric	All Sizes	1 Inch Thick	1
	Outside Building Envelope	Elastomeric	All Sizes	1-1/2 Inch Thick	1,3
	In Utilidors	Cellular Glass	All Sizes	1 Inch Thick	2
Hot Plumbing Piping	Inside Building Envelope	Fiberglass or Elastomeric	1-1/4 Inch and Smaller	1-1/2Inch Thick	1
			1-1/2 Inch and Larger	1-1/2 Inch Thick	1
	Outside Building Envelope	Elastomeric	All Sizes	2 Inch Thick	1, 3
	In Utilidors	Cellular Glass	All Sizes	1 Inch Thick	2
Cold HVAC Piping	Inside Building Envelope	Fiberglass or Elastomeric	1-1/4 Inch and Smaller	1 Inch Thick	1
			1-1/2 Inch and Larger	1-1/2 Inch Thick	1
	Outside Building Envelope	Elastomeric	All Sizes	1-1/2 Inch Thick	3
	In Utilidors	Cellular Glass	All Sizes	1 Inch Thick	2
Hot HVAC Piping with Temp less than 140 F	Inside Building Envelope	Fiberglass or Elastomeric	1-1/4 Inch and Smaller	1-1/2 Inch Thick	
			1-1/2 Inch and Larger	1-1/2 Inch Thick	
	Outside Building Envelope	Elastomeric	All Sizes	2 Inch Thick	3
	In Utilidors	Cellular Glass	All Sizes	2-1/2 Inch Thick	2
Hot HVAC Piping with Temp 141 to	Inside Building Envelope	Fiberglass or Elastomeric	1-1/4 Inch and Smaller	1-1/2 Inch Thick	

TYPE OF PIPE	INSTALLATION LOCATION	INSULATION TYPE	PIPE SIZE (INCHES)	INSULATION THICKNESS (INCHES)	NOTES
200 F			1-1/2 Inch and Larger	2 Inch Thick	
	Outside Building Envelope	Elastomeric	All Sizes	2 Inch Thick	3
	In Utilidors	Cellular Glass	All Sizes	3 Inch Thick	2
Refrigerant Suction and Liquid Lines	All Locations	Elastomeric	3/4 Inch and Smaller	1 Inch Thick	3
			1 Inch and Larger	2 Inch Thick	3

Notes:
1. Including polyethylene and polypropylene tubing.
2. Include multi-ply laminate jacket.
3. Include factory applied weatherable jacket or manufacturer recommended coating.

3.14 EXTENT OF DUCT INSULATION

A. Insulate ductwork in the Contract Documents per the following table:

LOCATION OF DUCT	DUCT SYSTEM TYPE	DUCT CONFIGURATION	INSULATION TYPE	MINIMUM R-VALUE, INSULATION THICKNESS	NOTES
Duct Not Within Conditioned Space	Supply, Return, Exhaust, Mixed, Outside, Relief, and Transfer Air Ducts	Rectangular – Exposed	Rigid Board or Elastomeric	R-7, 1 Layer, 2 Inch Thick	
		Rectangular – Concealed	Duct Wrap or Elastomeric	R-7, 1 Layer, 3 Inch Thick	
		Round and Oval Duct	Duct Wrap or Elastomeric	R-7, 1 Layer, 3 Inch Thick	
Duct Within Conditioned Space	Supply, Air Ducts	Rectangular - Exposed	Rigid Board or Elastomeric	R-3.3, 1 Inch Thick	
		Rectangular – Concealed	Duct Wrap or Elastomeric	R-3.3, 1 Layer, 1-1/2 Inch Thick	
		Round and Oval	Duct Wrap or Elastomeric	R-3.3, 1 Layer, 1-1/2 Inch Thick	

	Mixed and Outside Air Ducts	Rectangular – Exposed	Rigid Board or Elastomeric	R-7, 1 Layer, 2 Inch Thick	
		Rectangular – Concealed	Duct Wrap or Elastomeric	R-7, 1 Layer, 3 Inch Thick	
		Round and Oval	Duct Wrap or Elastomeric	R-7, 1 Layer, 3 Inch Thick	
Ducts and Plenums Within Conditioned Space Functioning as Part of Building Envelope	All Duct Types	Rectangular	Rigid Board or Elastomeric	R-Value Equal to Building Envelope, Thickness as Required	1
		Round and Oval	Duct Wrap or Elastomeric	R-Value Equal to Building Envelope, Thickness as Required	1
Notes: 1. Insulate outside, exhaust, and relief air ducts from building envelope to motorized and backdraft dampers with R-value equal to building envelope thickness.					

B. Ducts Specified to Have Soundlining and Factory Soundlined Ducts: Refer to Section 233100. Need not be insulated unless additional insulation is required to meet thickness requirements of this section.

END OF SECTION 230700

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. Commissioning process requirements for HVAC&R systems, assemblies, and equipment.

B. Related Sections:

1. Section 01 91 00 "General Commissioning Requirements".
2. Division 22 “Plumbing”.
3. Division 23 “Heating, Ventilating, and Air Conditioning (HVAC)”.
4. Division 26 “Electrical”.

2.1 GENERAL DESCRIPTION

A. Commissioning Authority (CA)

1. The CA has been contracted directly with the owner for this project. The CA has overall responsibility for planning and coordinating the commissioning process. However commissioning involves all parties to the design and construction process, including the mechanical (Division 23) contractor, and all specialty sub-contractor within Division 23, such as sheet metal, piping, refrigeration, water treatment, and controls, plus major equipment suppliers as required.

B. Contractor Responsibility

1. The mechanical (Division 23) contractor’s responsibilities are defined in Section 01 91 00 of the specifications. These responsibilities apply to all specialty sub-contractors and major equipment suppliers within Division 23. Each contractor and supplier shall review Section 01 91 00, and their bids shall include for carrying out the work described, as it applies to each Section within the Division 23 specifications, individually and collectively.

C. HVAC Equipment and Systems to be Commissioned

1. Heat exchanger / recovery
2. Self-contained air conditioning units / heat pumps / Variable Refrigerant Systems
3. Dedicated Outside Air Systems
4. Room HVAC – Air terminal units / space and building pressurization / natural ventilation
5. Radiators
6. Test, Adjust and Balance
7. Building Automation System

PART 2 - PRODUCTS

1.1 Refer to Section 019100 “General Commissioning Requirements” for minimum testing instrumentation criteria and performance.

2.1 Standard certified test equipment for commissioning will be provided by the Commissioning Authority.

3.1 All proprietary testing equipment and instrumentation required to verify and test system and equipment performance shall be provided by installing contractor and made available to the Commissioning Authority.

PART 3 - EXECUTION

1.1 GENERAL TESTING REQUIREMENTS

A. Contractor shall provide technicians, instrumentation, and tools to perform commissioning tests at the direction of the CA and as outlined in Section 019100 "General Commissioning Requirements".

B. Scope of HVAC&R testing shall include the entire HVAC&R installation, from central equipment for heat generation and refrigeration through distribution systems to each conditioned space. Testing shall include measuring capacities and effectiveness of operational and control functions.

C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system (BAS) controllers and sensors.

D. The CA shall prepare detailed testing plans, procedures, and checklists for HVAC&R systems, subsystems, and equipment.

E. Tests will be performed using design conditions whenever possible.

F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.

G. The CA may direct that set points be altered when simulating conditions is not practical.

2.1 INSTALLATION VERIFICATION AND START-UP ACTIVITIES

A. Refer to General Commissioning Specification Section 019100.

3.1 TEST, ADJUST AND BALANCE VERIFICATION

A. Refer to General Commissioning Specification Section 019100.

B. The CA will notify TAB Contractor in advance of the date of field verification. The air balancing and water balancing will be de-bugged, completed and approved before the CA completes a TAB validation of air-related and water-related equipment or systems. The CA will direct a TAB checkout by verifying the values reported in the final TAB report. Advanced notice will not include data points to be verified.

C. The TAB Contractor shall use the same instruments (by model and serial number) that were used when original data were collected. The contractor shall also provide equipment necessary for checkout including, but not limited to, tools, instruments, ladders, lifts, computers, software, cables, etc.

4.1 POINT TO POINT VERIFICATION AND FUNCTIONAL PERFORMANCE TESTING

A. Refer to General Commissioning Specification Section 019100.

B. Functional performance testing and verification may be achieved by manual testing (persons manipulate the equipment and observe performance) or by monitoring the performance and analyzing the results using the control system's trend log capabilities or by stand-alone dataloggers.

C. Simulated Conditions. Simulating conditions (not by an overwritten value) shall be allowed, though timing the testing to experience actual conditions is encouraged wherever practical.

D. Overwritten Values. Overwriting sensor values to simulate a condition, such as overwriting the outside air temperature reading in a control system to be something other than it really is, shall be allowed, but shall be used with caution and avoided when possible. Such testing methods often can only test a part of a system, as the interactions and responses of other systems will be erroneous or not applicable. Simulating a condition is preferable. e.g., for the above case, by heating the outside air sensor with a hair dryer rather than overwriting the value or by altering the appropriate setpoint to see the desired response. Before simulating conditions or overwriting values, sensors, transducers and devices shall have been calibrated.

E. Altering Setpoints. Rather than overwriting sensor values, and when simulating conditions is difficult, altering setpoints to test a sequence is acceptable. For example, to see the AC compressor lockout work at an outside air temperature below 55º F, when the outside air temperature is above 55º F, temporarily change the lockout setpoint to be 2º F above the current outside air temperature.

F. Setup. Each function and test shall be performed under conditions that simulate actual conditions as close as is practically possible. The Sub executing the test shall provide all necessary materials, system modifications, etc. to produce the necessary flows, pressures, temperatures, etc. necessary to execute the test according to the specified conditions. At completion of the test, the Sub shall return all affected building equipment and systems, due to these temporary modifications, to their pre-test condition.

5.1 TRAINING

A. Refer to General Commissioning Specification Section 019100.

6.1 OPERATION AND MAINTENANCE MANUALS

A. Refer to General Commissioning Specification Section 019100.

END OF SECTION 230800

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Description: The Work includes training the Owner's personnel in operation, maintenance, and management of fire suppression, plumbing, and HVAC systems.

B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to the Work in this section.

1.2 SCOPE OF WORK

A. Fire suppression, plumbing, and HVAC systems training shall be both classroom and field sessions to introduce operation, maintenance and management personnel to Operations and Maintenance Manuals, drawings, and other documents and aids available to operate and maintain equipment. Training shall occur following installation of fire suppression, plumbing, and HVAC work and prior to final acceptance. Commence instruction periods with approved Operations and Maintenance Manuals.

B. Factory trained specialists in area of major equipment and system shall present sessions on their specific equipment and system. For control systems specified in Section 230900, representative shall be the technician who performed testing and adjustment.

C. Conduct extensive hands-on training during fire suppression, plumbing, and HVAC systems preliminary commissioning so that actual operations and maintenance of equipment and systems could be the responsibility of operation, maintenance and management personnel at completion of preliminary commissioning if the Owner so chooses. Conduct instructions in appropriate sessions. Comply with total minimum hours specified in individual specification sections.

D. Conduct a subsequent training session 90 days after occupancy to answer Owner's questions and review training instructions. This session shall also be by factory trained specialists. Include 8 hours for this session.**]**

E. Video record training sessions with emphasis of video subject and hands-on equipment operation. Following training sessions, deliver 2 copies of DVD to the Owner.

1.3 VISUAL AIDS

A. Utilize visual aids, such as slides, video, and movies. Visual aids shall be made a part of the Owner's permanent files.

1.4 TRAINING TIME ALLOWANCE

A. General: Include in Bid total hours listed below for each section. Refer to specific section for additional training requirements.

1. DIVISION 21:

a. SECTION 211000 AUTOMATIC FIRE SUPPRESSION SYSTEMS: Total of 2 hours.

2. DIVISION 22:

a. SECTION 221116 DOMESTIC WATER SYSTEM: Total of 2 hours.
b. SECTION 221120 PLUMBING VALVES: Total of 1 hours.
c. SECTION 221123 PLUMBING PUMPS: Total of 1 hours.
d. SECTION 221300 SOIL, WASTE, VENT, AND STORM DRAIN SYSTEM: Total of 1 hours.
e. SECTION 223000 PLUMBING EQUIPMENT: Total of 2 hours.

3. DIVISION 23:

a. SECTION 230800 MECHANICAL SYSTEMS COMMISSIONING: Total of 16 hours.
b. SECTION 230900 AUTOMATIC TEMPERATURE CONTROLS: Total of 16 hours.
c. SECTION 230915 VARIABLE FREQUENCY DRIVES: Total of 1 hours.
d. SECTION 232113 HYDRONIC PIPING SYSTEMS: Total of 1 hours.
e. SECTION 232120 HYDRONIC VALVES: Total of 1 hours.
f. SECTION 232123 HYDRONIC PUMPS: Total of 1 hours.
g. .
h. SECTION 232300 REFRIGERANT PIPING: Total of 1 hours.
i. SECTION 232500 WATER TREATMENT: Total of 1 hours.
j. SECTION 233100 AIR DISTRIBUTION: Total of 2 hours.
k. SECTION 233300 AIR DISTRIBUTION ACCESSORIES: Total of 1 hours.
l. SECTION 233400 AIR DISTRIBUTION EQUIPMENT: Total of 2 hours.
m. SECTION 236420 AIR COOLED CHILLERS: Total of 1 hours.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

3.1 FIRE SUPPRESSION, PLUMBING, AND HVAC SYSTEMS TRAINING

A. General: Operator training shall provide a complete overview of equipment, components, and systems with an emphasis on:

1. Documentation in the preliminary Operations and Maintenance Manuals.

2. How to use the Operations and Maintenance Manuals.
3. System operational procedures for all modes of operation, including warm-up, cool-down, occupied, unoccupied, start-up, shut-down and similar cycles.
4. Acceptable tolerances for system adjustments in operating modes including noise and vibration adjustments and economy and efficiency adjustment.
5. Procedures for dealing with abnormal conditions including emergency operations.
6. Hazards and safety.
7. Automatic temperature control sequences of operation.
8. Review of maintenance and operations in relation to written applicable warranties, agreements to maintain and service and similar continuing commitments.
9. Seasonal de-commission and re-commission.

B. Schedule: Submit training schedule and agenda to the A/E and the Owner for approval 4 weeks prior to first training session.

C. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain equipment, systems, and subsystems. Furnish educational materials and tools needed to conduct training sessions.

D. Typical Agenda as Follows:

1. Opening remarks.
2. Introduction.
3. Description of HVAC Systems:

    a. Air Side:

        1) Cooling.
        2) Heating.
        3) Ventilation.
        4) Life safety.

    b. Wet Side:

        1) Cooling.
        2) Heating.

4. Description of HVAC Equipment and Systems (Individual Suppliers Shall Discuss Equipment):

    a. Wet Side:

        1) Refrigeration Equipment:

            a) Accessory equipment.
            b) Electrical.
            c) Control.
            d) Refrigerant piping.

        2) Hydronic:

            a) Pumps.

b) Chiller.
c) Piping and valves.
d) Controls.
e) Water treatment.
f) Electrical.

3) Chillers:

a) Water treatment.
b) Piping.
c) Controls.
d) Safety accessories.
e) Electrical.

4) Insulation.

b. Air Side:

1) Air Handling Units and Fans:

a) Fans.
b) Coils.
c) Heat exchangers.
d) Controls.
e) Electrical.
f) Vibration isolation.
g) Insulation.

2) Duct System:

a) Type(s).

c. Pressure Controls:

1) System type.
2) Purpose.

5. Description of Plumbing Equipment and Systems:

a. Piping and valves.
b. Pumps.
c. Plumbing fixtures.
d. Plumbing fixture faucets and flush valves.
e. Trap primers.

6. Description of Fire Suppression Systems:

a. Alarm valve assemblies.
b. Piping and valves.
c. Valve tamper switches.
d. Review of NFPA 25.

7. Walk--through of building (project).
8. Start--up Procedures:

    a. Seasonal considerations.
    b. Check list.
    c. Emergency procedures.

9. Operation Procedure:

    a. Occupancy considerations.
    b. Seasonal considerations (changeover).
    c. Manual/automatic.
    d. Emergency.

10. Shut Downs:

    a. Check list.
    b. Normal.
    c. Emergency.
    d. Alarms and resets.

11. Maintenance of HVAC, Fire Suppression, Plumbing, and HVAC Systems:

    a. Routine.
    b. Preventive.
    c. Service.
    d. Lubrication.
    e. Overhaul.
    f. Factory.
    g. Cleaning.
    h. Access provisions.

12. Warranties:

    a. What they cover.
    b. How to use them.

13. Spare Parts.
14. Tools:

    a. Normal tools, supplies and equipment.
    b. Special tools.

15. Hands--on operation of fire suppression, plumbing, and HVAC system equipment in conjunction with preliminary commissioning.
16. Sequence of operation of fire suppression, plumbing, and HVAC system during fire emergency.
17. Fire Dampers, Ceiling Radiation Dampers, Smoke Dampers, and Combination Fire/Smoke Dampers: Describe maintenance requirements for and demonstrate testing of fire dampers and ceiling radiation dampers in accordance with NFPA 80, Standard for Fire Doors and Other Opening Protectives and for smoke dampers and combination

fire/smoke dampers in accordance with NFPA 105, Standard for Smoke Door Assemblies and Other Opening Protectives.

3.2 RETRAINING

A. After fire suppression, plumbing, and HVAC system commissioning, instruct Owner's operations and maintenance personnel on changes and reconfiguration which may have occurred during commissioning process.

END OF SECTION 230810

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Description: The Work includes preparation of mechanical systems Operations and Maintenance Manuals.

B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to the Work in this section.

1.2 SCOPE OF WORK

A. General:

1. Comply with requirements in Division 01 with additional requirements indicated in this article. Provide total of 3 hard copies and 1 electronic copy. In addition, provide 2 additional hard copies of automatic temperature controls, Section 230900.
2. For each component and systems listed in Article “Table of Contents” in this section and furnished and installed by the Contractor, include the following (both in hard and electronic format). Include a basic description of systems.

B. Product Data and Parts List: Include local source of supply for parts and replacement. List parts and components of equipment stating catalog number (serial number and ratings, such as HP, voltage, and GPM.) and size of part used in or on equipment. Include information pertinent to specific project and annotate each page to clearly identify specific product or part installed and identify data applicable to installation. Delete references to inapplicable information.

C. Master Preventive Maintenance Schedule and Procedures: Include safety precautions and safety features.

D. For Equipment and Components:

1. Troubleshooting Guide: Include equipment functions, operating characteristics, and limiting conditions.
2. Manufacturer’s Installation Instructions: Include assembly, installation, wiring diagrams, alignment, adjustment, and checking instructions.
3. Manufacturer’s Service Instructions. Include suggested frequency of maintenance and list of lubricants.
4. Start-up Instructions with Certificates of Start-up and Verification: Include test data and performance curves, routine and normal operation, regulation and control, shutdown and emergency conditions.
5. Final approved submittals.

E. Warranties: Copy of each warranty, guarantee, bond, and maintenance/service contract issued. Include information for the Owner’s personnel indicating proper procedures in event of failure and instances which might affect validity of warranties. State warranty start date and duration of components.

F. Maintenance and service contracts (if specified).

G. Final testing, adjusting, and balancing reports.

H. Filters: Include sizes, quantities, and locations.

I. Belts: Include sizes, quantities, and locations.

J. Fuses: Include list.

K. Video record main underground waste piping and furnish a copy of DVD to the Owner.

1.3 SUBMITTALS

A. Comply with requirements in Division 01 and Section 230500.

B. Submit preliminary copy of the Operations and Maintenance Manual in 1 package. Incomplete, “piece-meal” submittals not acceptable and will be returned unreviewed.

C. Submit completed preliminary copy of Operations and Maintenance Manuals to the A/E for review and approval. Submit approved Operations and Maintenance Manuals to the Owner minimum 60 days before instruction periods as specified in Section 230810. Commence with review comments and corrective measures identified during these procedures being incorporated. Following instruction periods, incorporate corrective measures and submit final Operations and Maintenance Manuals.

D. Final Operations and Maintenance Manuals in both hard and electronic formats.

1.4 TABLE OF CONTENTS

A. Warranty

B. Preventative Maintenance Schedule

C. Maintenance and Service Contracts

D. Filter List

E. Belt List

F. Fuse List

G. Valve Location Drawings

H. Final TAB Report

I. DIVISION 21 - Fire Suppression:

1. Grooved piping and couplings.
2. Valves.

3. Sprinkler heads.
4. Alarm valve assemblies.
5. Water flow detectors.

J. DIVISION 22 - Plumbing:

1. Fixtures.
2. Flush valves.
3. Faucets.
4. Valves.
5. Water heaters.
6. Hose bibbs and wall hydrants.
7. Meters.
8. Backflow preventers.
9. Trap primers.
10. Pumps.

K. DIVISION 23 - HVAC:

1. Chillers.
2. Water treatment.
3. Pumps.
4. Valves.
5. Air handling units.
6. Packaged HVAC equipment.
7. Pressure switches.
8. Backdraft dampers.
9. Fans.
10. Expansion tanks.
11. Fire dampers, ceiling radiation dampers, smoke dampers, and combination fire/smoke dampers.
12. Temperature Controls:

    a. Thermostats and temperature sensors.
    b. Other sensors.
    c. Sequences of operation with final setpoints.
    d. As-built wiring diagrams including line and low voltage wiring between field components and HVAC control panels and equipment control panels.
    e. Point-by-point system verification checklist.
    f. DDC programming diagrams.
    g. Central operator workstation functions with specific software programming for installed systems.
    h. Control valves.
    i. Control dampers.
    j. Actuators.
    k. Variable frequency drives.
    l. Airflow measuring units.
    m. Equipment.
    n. Power backup.
    o. Floor plans of building with locations of controllers, actuators, sensors and transformers.
    p. Floor plans of building with location of equipment and their controls.

q. Spread sheet showing points and controls associated with piece of equipment and location of power source.

PART 2 - PRODUCTS

2.1 FORMAT

A. Submit preliminary Operations and Maintenance Manual to the A/E in hard copy format for review and approval.

B. Submit final Operations and Maintenance Manual to the A/E and the Owner in both hard copy and electronic format.

1. Hard Copy: Assemble Operations and Maintenance Manual in 3-ring binder(s). Use multiple binders if pages in a single binder would exceed 2-1/2 inch thickness. Separate binders for each category, such as Division 21 Fire Suppression, Division 22 Plumbing, and Division 23 HVAC. Where one subject matter encompasses more than one binder, differentiate by volume numbers. Include indexed tabs for each binder.
2. Electronic Copy: Assemble Operations and Maintenance Manual in one single Adobe PDF with bookmarks for each division, specification number, and part number.

C. The Operations and Maintenance Manual shall be provided also in electronic format (Excel, Word, and Bitmap). Performance data shall be in spreadsheet format and operation startup and troubleshooting information shall be in Word document. Diagrams shall be in bitmap format. Assemble AutoCAD drawings so that X-refs are automatically attached.

D. Fold drawings to 8-1/2 by 11 inch size and bind as above (with reinforcing at punched holes) or place in clear plastic holder designed for 3-ring binders.

E. Identify on cover and spine for each binder with printed title such as “FIRE SUPPRESSION”, “PLUMBING”, or “HVAC” OPERATIONS AND MAINTENANCE MANUAL”, names of project, Owner, general contractor, subcontractor, Architect, mechanical engineer, and year of project completion.

F. Include in each binder and volume material specified in Articles “Scope of Work” and “Table of Contents” in this section for ease of reference and use. Binders shall have a commercial quality stiff cover, metal-hinged, with durable and cleanable plastic covers.

G. Include overall table of contents of items submitted organized by system (not by specification section).

H. Include heavy, tabbed divider sheet for each category with title on tab. Include table of contents for category, including catalog numbers or drawings numbers if appropriate.

I. Include names, addresses and phone numbers of equipment suppliers.

J. Include Record Drawings reduced proportionately.

PART 3 - EXECUTION

Not used.

END OF SECTION 230820

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Description: The Work includes design, components, hardware, and construction for complete installation of operational Direct Digital Control (DDC) system.

B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to the Work in this section.

C. Extent: Provide new control systems including associated equipment and accessories. Provide control system complete and operating as required by the Contract Documents. Manufacturer's products, including design, materials, fabrication, assembly, erection, examination, inspection, and testing shall be in accordance with NFPA 70, except as indicated otherwise on the Drawings and this section.

D. Although such work is not specifically indicated on the Drawings or in this section, include supplementary and miscellaneous items, appurtenances, and devices incidental to or necessary for sound, secure, and complete operating installation.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable city, county and state codes and ordinances.

B. Codes and Standards:

1. Applicable energy code.
2. AMCA Standard 500-D, Laboratory Methods of Testing Dampers for Rating.
3. AMCA Publication 511, Certified Ratings Program – Product Rating Manual for Air Control Devices.
4. ANSI C12.10, Physical Aspects of Watt hour Meters – Safety Standard.
5. ASHRAE Standard 135 (BACnet).
6. ASHRAE BACnet Protocol Standard.
7. ASME B16.5, Pipe Flanges and Flanged Fittings NPS 1/2 through 24 inch Standard.
8. ASME B16.18, Cast Copper Alloy Solder Joint Pressure Fittings.
9. ASME B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
10. ASME B16.26, Cast Copper Alloy Fittings for Flared Tubes.
11. ASTM A 126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
12. ASTM B 32, Standard Specification for Solder Material.
13. ASTM B 75, Standard Specification for Seamless Copper Tube.
14. ASTM B 88, Standard Specification for Seamless Copper Water Tube.
15. ASTM B 280, Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Services.
16. BACnet Testing Laboratories (BTL).
17. CSA, Canadian Standards Association.
18. FCC, Part 15, Subpart J, Class A Computing Devices.
19. IEEE C57.13, IEEE Standard Requirements for Instrument Transformers.

20. IEEE Std. 587, Applicability to Adjustable Frequency Control (Surge Voltages).
21. NFPA 70, National Electrical Code.
22. NFPA 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems.
23. UL 506, Standard for Specialty Transformers.
24. UL 873, Standard for Temperature-Indicating and -Regulating Equipment.
25. UL 916, Standard for Energy Management Equipment.
26. UL 1449, Standard for Surge Protective Devices.
27. UL 2034, Standard for Single and Multiple Carbon Monoxide Alarms.
28. UL 2075, Standard for Gas and Vapor Detectors and Sensors.
29. UL 61010-1, Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use – Part 1: General Requirements.
30. UL 61010B-1, Electrical Measuring and Test Equipment; Part 1: General Requirements.

C. DDC System Subcontractor's Qualifications:

1. Subcontractor that will perform the Work shall have completed at least 10 control systems installations of same type and design as required by the Contract Documents which have successfully operated required sequences of operation for at least 3 years.

D. DDC System Support:

1. System subcontractor's office within 50 mile radius of job site.
2. Subcontractor shall respond to job site within 2 hour period for emergencies relating to control system.
3. Emergency response is defined as having a technician actively troubleshoot and correct problem either at job site or via modem link to system.

E. Standard Products:

1. Material and equipment standard products of manufacturer regularly engaged in manufacturing of such products. Standard products shall have been in commercial or industrial use for 1 year prior to bid opening. One year use shall include applications of similarly sized equipment and materials used under similar circumstances.
2. Equipment items supported by a service organization.

F. DDC System Verification: Become familiar with details of the Work and verify dimensions in field. Advise the A/E of any discrepancy before performing the Work.

G. Operator Workstation System Architecture: Implement to conform to industry standard Application Specific Interfaces (ASIs) to accommodate applications available from DDC system subcontractor or by third party application suppliers, such as Microsoft Office Applications. Implement to conform to the following:

1. Historical information and configured data contained in databases accessible via Open Database Connectivity (ODBC) or Structured Query Language (SQL). Software ODBC compliant such that trend information and use of third party graphic program, report writing, and spreadsheets are possible without conversion routines.
2. Real-time, online, building data accessible for applications such as graphics and reports via OLE for Process Control (OPC).
3. Real-time event data such as alarms, change of state events and warning events via OPC.
4. Include OPC data servers for communicating to DDC system any OPC compliant clients.

H. Installation: System designed and constructed by authorized representative of product manufacturer. Carefully investigate mechanical, electrical, and finish conditions that could affect work to be performed and furnish materials and labor necessary to meet such conditions.

I. Stability and Accuracy: Provide DDC system to maintain stable control and other conditions as specified. End-to-end accuracy of system, including temperature sensor error, wiring error, A/D conversion, and display, shall be 1 F. Room temperature control shall be DDC with electric valves and dampers.

J. BACnet Compatibility: Furnish totally native BACnet system such that central operator workstation, global controllers, logic controllers, and input/output devices communicate using protocols and Local Area Network (LAN) standards as defined by ASHRAE Standard 135, BACnet. Workstations and controllers, including unitary controllers, shall be compatible native BACnet devices. No gateways shall be used. Entire processing system shall comply with ASHRAE Standard 135. DDC system shall use BACnet protocols and LAN types throughout and exclusively. Non-BACnet-compliant or proprietary equipment or systems (including gateways) not acceptable.

1.3 SUBMITTALS

A. General: Comply with requirements in Division 01 and Section 230500.

B. Product Data: Submit manufacturer's technical product data and maintenance data for the following:

1. Direct digital control system hardware.
2. Direct digital control system software.
3. Network and network communications.
4. Sensing and control hardware.
5. Controlled hardware.
6. Variable frequency drives (VFD).
7. Auxiliary components.
8. Electric power and distribution.
9. Control wiring.
10. Combination carbon monoxide (CO) and nitrogen dioxide (NO_2) detection and control system.
11. Hydronic flow and Btu meter system.
12. Surge protection for DDC systems.
13. Lighting control.

C. Shop Drawings:

1. General: After approval of product data, submit Shop Drawings. Label components with tag numbers. Include index of symbols and abbreviations. Do not commence installation until Shop Drawings are accepted by the A/E.
2. Schematic Diagrams:

   a. Include for each system (for example, fan system, pumping system, process) showing controls, relays, motor starters, contactors, control valves, actuators, switches, and associated components.
   b. Indicate instrument settings.

c. Indicate field wiring and interconnecting equipment and devices.
d. Identify type and size of wire and assign unique numbers or colors to every wire.
e. Identify equipment and devices by reference designators. Include materials list on each drawing.
f. Block diagrams and schematics showing layout of computers, controllers, communication cabling, wire type, count and conduit fill.
g. Schematic showing general mechanical system layout with sensors/devices of each mechanical system shown with corresponding detail and labeling.
h. Include items not specified herein or indicated on the Drawings but necessary to perform functions in sequences of operation for a complete and operational control system.

3. Floor Plans: Indicate locations of systems, equipment, components, and wiring. Identification consistent with nomenclature used in other documentation.
4. Sequences of Operation:

a. Include narrative description for each system based on vendor's implementation of control logic.
b. Include initial values of variables. Variables described as user adjustable shall also be available for adjustment at operator work station.
c. Sequences of operations shall describe not just what equipment does, but also how equipment achieves its desired performance.
d. Sequences of operation shall also be available as text file on central operator work station.
e. Sequences of operation as presented on the Drawings not acceptable.

5. Surge Protection for DDC System: Indicate details of devices and their installations.
6. DDC Panels: Submit physical layout and schematics including diagram of terminal strips, terminal strip locations, termination numbers and associated point names. For each input and output physically connected to a digital controller, include, on a controller by controller basis, the following:

a. Point Description: For example, mixed air temperature, supply fan start/stop, and similar points.
b. Point Type: Analog Output (AO), Analog Input (AI), Digital Output (DO), Digital Input (DI).
c. Point Range: For example, 4 to 20 mA.
d. Sensor Range Associated with Point Range: For example, 0 F to 100 F, 0 to 2 inch w.g.
e. Software names associated with each point.
f. Software address of each connected point to which each point is connected.

7. Sample Graphics: Provide for each type of screen, including floor plans, elevations, system, and equipment. Submit at least one month before graphics implementation.
8. Typical Wiring Diagrams:

a. Indicate internal wiring of control panels.
b. Indicate general physical arrangement of component devices installed in control panels.
c. Include elementary ladder diagrams to show function of circuits employing switching logic.
d. Include panel schedule show in location, systems served and point count.

e. Indicate DDC sensor and control wiring and installation diagrams for each type of input and each type of output device.

D. DDC Software Data: Submit descriptions of system, command, and applications software.

E. DDC Point List: Submit complete input/output summary ("point list") to document system points and their associated functions as required by sequences of operation indicated on the Drawings. Include control points, monitoring points, and alarm points.

F. Qualifications: Submit documentation as defined under Paragraph "DDC System Subcontractor's Qualifications".

G. Smoke Dampers and Combination Fire/Smoke Dampers. Submit documentation that controls subcontractor has reviewed and confirmed configuration of actuator location prior to dampers and actuators being ordered.

H. ASHRAE Standard 135: Submit Protocol Implementation Conformance Statements (PICS).

I. DDC System Field Test Documentation:

1. Functional Tests: Submit test report forms demonstrating compliance with Article "Field Testing and Verification". Documentation shall consist of expected and actual response of sensors, actuators, and controllers. Submit documentation by means trend graphs for DDC system of control loop stability and accuracy, proper execution of sequences of operation, and proper operation of equipment interlocks.

J. Record Documents:

1. General: Submit Shop Drawings for each control system showing installed condition. As a minimum, include diagrams and documents listed in Paragraph "Shop Drawings" with sequences of operation. Include test report forms specified in Paragraph "DDC System Field Test Documentation". Submit documents in commonly readable and modifiable formats. Drawings in AutoCAD ".dwg" format. Other documents in Microsoft ".xls" or ".doc" formats acceptable. Include controller databases, graphics databases, and server and operator workstation configuration files.
2. Flow Charts and Wiring Diagrams: Include in 11 inch x 17 inch size, laminated, and bundled with "ring". Locate entire bundled set at central operator workstation. In addition, for specific diagrams, locate at their respective enclosure.

1.4 DDC SYSTEM OPERATIONS AND MAINTENANCE MANUAL

A. General: Comply with requirements in Division 01 and Sections 230500 and 230820. Include the following:

1. Functional design.
2. Hardware.
3. Software.
4. Operation.
5. Maintenance.

B. Functional Design: Operational requirements of system, theory of operation, design philosophy, and specific functions. Include description of hardware and software functions, interfaces, and requirements for system operating modes.

C. Hardware:

1. General description and specifications.
2. Installation and checkout procedure.
3. Equipment electrical schematics and layout drawings.
4. System schematics and I/O wiring lists.
5. Alignment and calibration procedures.
6. Manufacturer's repair parts list indicating sources of supply.
7. Interface definition.

D. Operation: Procedures and instructions for operation of system. Include the following:

1. System start-up and shut-down.
2. Use of system, command, and applications software.
3. Alarm presentation.
4. Recovery and re-start procedures.
5. Use of report generator including trendlogs.

E. Maintenance: Descriptions of maintenance for equipment including inspection, periodic preventative maintenance, fault diagnosis, and repair or replacement of defective components.

F. Shop Drawings: Include in both hard copy and in CD/DVD formats.

1.5 DDC SYSTEM SOFTWARE

A. General: Include licenses and registration cards for included software, device drivers, and peripherals.

1.6 DDC DATABASE

A. General: Develop and implement database for DDC points and controls required for sequences of operation and point monitoring. Designate person with 2 years minimum experience in database generation procedures of DDC system for this purpose.

B. Data: Prepare data entry forms utilizing data from the Contract Documents, field surveys, and other pertinent information required for complete installation of database. Identify and request from the Owner any additional data needed to provide complete and operational DDC system including, but not limited to, proper room identification information and scheduled hours of occupancy. Submit forms requesting this additional information to the Owner at least 60 days prior to need for such information.

1.7 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Section 232113 – Hydronic Piping Systems: Water pressure and differential taps, thermal wells, flow meters, and similar components installed in piping. Supervision of installation of these components by the DDC system subcontractor.

B. Section 232113 – Hydronic Piping Systems: Actuator for installation at factory by flow control valve assembly manufacturer.

C. Section 233100 – Air Distribution: Duct smoke detectors.

D. Section 233300 – Air Distribution Accessories: Variable air volume (VAV) terminal box controllers and actuators for installation at factory by terminal unit manufacturer.

E. Section 233300 – Air Distribution Accessories: Motorized dampers. Supervision of installation of these components by DDC system subcontractor.

1.8 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION

A. Section 233400 – Air Distribution Equipment: Remote temperature controller for heat recovery unit.

B. Section 238100 – Packaged HVAC Equipment: Zone temperature sensors, thermostats, and similar control devices.

1.9 RELATED WORK

A. Testing, Adjusting, and Balancing (TAB) Work:

1. Furnish 24 hours personnel to TAB organization specified in Section 230593 to provide adjustments to control system for setup of TAB work. Adjustments to control system following completion of TAB work shall maintain settings of TAB work.
2. TAB work will be performed once during winter conditions and once during summer conditions for systems which are affected by exterior environment. Winter TAB work will occur while outdoor air temperature is below 40 F and summer TAB while outdoor air temperature is above 75 F. (Exception: Simulation facilitating equivalent balancing and testing is permitted as approved by the A/E).
3. Include services of DDC system start-up technician for 16 hours to operate DDC system during capacity tests, flow tests, minimum outdoor airflow tests, and other tests for which TAB work requires adjustments to DDC system.
4. For DDC terminal unit controls, include start-up technician support and hand held operator's terminal to TAB organization. Assist and train TAB technicians on at least 20 different terminal unit controllers, 16 hours minimum.
5. Fine tune controls after TAB work is complete.

B. Plumbing Equipment, Boiler, Heat Pump Chiller, Air Distribution Equipment, and Variable Frequency Drives Work.

1. Furnish 16 hours personnel to meet with mechanical and electrical subcontractors and mechanical engineer as specified in Sections 223000, 230915, 233400, 235200, and 236420 to assure that all parties understand what interconnections are required.
2. Be present and participate in the equipment manufacturer's start-up services specified in Sections 223000, 230915, 233400, 235200, and 236420.

1.10 WARRANTY

A. Include services, materials and equipment necessary for successful operation of DDC system for period of one year after final acceptance date.

B. Adjustment, required testing, and repair of system includes computer equipment, transmission equipment and sensors, and control devices.

C. On-line support services shall allow local DDC subcontractor to dial out over telephone lines or Internet to monitor and control facility's building automation system. This remote connection to facility shall be within 2 hours of time that problem is reported. This coverage shall be extended to include normal business hours, after business hours, weekends, and holidays. If problem cannot be resolved with on-line support services, DDC system manufacturer shall dispatch appropriate personnel to job site to resolve problem within 3 hours of time that problem is reported.

D. Furnish 2 copies of software updates on CD/DVD that occur within warranty period.

1. Install one copy in central operator workstation and deliver second copy to the Owner.
2. Notify the Owner in writing as to updates that occur during subsequent 3 years following completion of warranty period.

E. At end of warranty period, DDC system subcontractor shall re-check entire system operation, including calibration testing of sample number of components and performing necessary control adjustments for proper system operation. Such work shall be for minimum of 16 man-hours in conjunction with the Owner's technicians.

1.11 SPARE PARTS

A. Controllers: Two unitary controllers and 2 VAV unit and FTU controllers. Deliver to the Owner at Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturer: Johnson Controls by Automated Controls. No substitutions.

2.2 DIRECT DIGITAL CONTROL SYSTEM HARDWARE

A. General:

1. DDC distributed control system with DDC controllers and communications network.
2. Operator programmable, based on user applications, to perform closed-loop, modulating control of building equipment.
3. Connect DDC controllers through communication network to share common data and report to central operator workstation computers.
4. Central operator workstation capable of being programmed to supervise DDC controllers.
5. DDC system capable of down-loading and up-loading of programs between central operator workstation and DDC controllers.

B. Stand-Alone and Application Specific Controllers:

1. General: Dedicated specific-use controllers with communication links to supervisory and global controllers to receive global information and send alarm and trouble signals.

    a. Include necessary input and output points to perform required monitoring and control. Failure mode programmable.
    b. Capable of accepting inputs for miscellaneous points such as fire alarm, lighting, and irrigation.
    c. Inputs: Input functions integral to DDC controller. Input type as required by DDC system design.

        1) Analog Inputs: Thermistors 0 to 10 V DC or 4 to 20 mA. Appropriate conversion curves stored in controller software or firmware.
        2) Digital Inputs: Open/close, on/off, pulse, or other 2 state sensing.
        3) Actuator Feedback:

            a) Digital input for two-position motor-operated dampers and control valves via end or reed switches in the actuators.

            b) Analog input for modulating motor-operated dampers and control valves via analog feedback relay in the actuators. Exception: Floating point actuators used for variable air volume (VAV) and fan powered terminal unit (FTU) dampers and heating water control valves.

    d. Outputs: Output functions integral to DDC controller. Output type as required by DDC system design.

        1) Analog Outputs: 0 to 10 V DC or 4 to 20 mA. Feedback integral to output function. Actuator feedback signal independent of control signal, wired and terminated in DDC panel.
        2) Digital Outputs: Contact closure type with contacts rated at 1 Amp minimum at 24 V.

    e. Application programs and parameter data stored in non-volatile memory (EEPROM).

2. Enclosures: Factory enclosure suitable for application. Plenum rated where installed in ceiling space used as return air plenum. Include heat sinks for heat dissipation.
3. Disconnects: Local disconnect switch to individually disconnect control power without interrupting other controllers.

4. Include additional 10 percent minimum input/output (I/O) points, but not less than 1 spare point for each type. Include hardware for each point, installed and ready for external wiring.
5. Air Handling Unit Controllers:

    a. System configuration to match application, including but not limited to the following:

        1) Mixed air, single path (constant and variable air volume systems).
        2) Mixed air, dual path.
        3) 100 percent outside air.
        4) Multizone.
        5) Return or relief fan.
        6) Hydronic heat.

    b. Agency Listing: UL 916 and UL 864.

6. Central Plant Controllers:

    a. System configuration to match application, including but not limited to the following:

        1) Chillers.
        2) Boilers.
        3) Mechanical rooms with multiple air handling units.

    b. Controller Includes:

        1) Real time clock for stand-alone scheduling and optimal start/stop. Include battery back-up.
        2) Proportional, proportional plus integral, and proportional plus integral plus derivative control capability.
        3) Password control.
        4) Expanded memory to retain data and trend logs.

7. Unitary Controllers:

    a. System configuration to match application, including but not limited to the following:

        1) Unit ventilators (ASHRAE Cycle I, II, III, or IV).
        2) Heat pumps (air to air, air to water).
        3) Packaged HVAC units.
        4) Fan coil units.

    b. Agency Listing: UL 916.

8. VAV Unit and FTU Controllers:

    a. System configuration to match application, including but not limited to the following:

1) Single duct only (cooling only or cooling with reheat).
2) Fan powered (parallel or series).

b. Support the following types of input and output points:

1) Proportional cooling output.
2) Proportional heating output.
3) Fan control output (on/off logic or proportional series fan logic).
4) Fan status input.
5) Space temperature input.
6) Velocity sensor input.
7) Auxiliary temperature input.
8) Override push-button.

c. Furnish to unit manufacturer for factory installation. Application programs and parameter data stored in nonvolatile memory (EEPROM).
d. Operator interface to point data or programs through terminal jack at room temperature sensor.
e. Agency Listing: UL 916 and UL 873.

C. Supervisory and Global Controllers with the Following Components:

1. General: Supervises and monitors mechanical equipment through network of stand-alone and application specific controllers.
2. Main power switch.
3. Self-test switch.
4. Power on indicator.
5. On-line indicator.
6. LEDs to indicate operating/communication status.
7. Real Time Clock:

a. Accurate to plus or minus 2 seconds per day. Every controller in DDC system capable of being fully integrated and programmed through on-site interface ports.
b. Protected by uninterruptable power source (sealed battery back-up or uninterruptable power supply (UPS)).
c. Back-up power source of sufficient capacity to maintain real-time clock in event of AC power failure.
d. Where uninterruptable power source is rechargeable (a rechargeable battery), include sufficient capacity for 72 hour minimum back-up.
e. Rechargeable power source constantly charged by charging circuitry while controller is operating under normal line power.
f. Batteries designed to allow replacement without soldering.

8. Memory: Sufficient to perform specified functions and operations including 10 percent spare memory for future expansion.
9. Application Programs: Built-in routines including password control, alarm processing, trending, totalization, scheduling, data base management, optimal start, demand limiting, and load rolling for stand-alone operation.
10. Controller-to-Controller LAN Communications Ports:

a. Communication port for each controller which allows direct connection to Local Area Network (LAN).

b. Ports designed for both peer controller function (upper level controllers) and application specific controller function (lower level controllers).

11. On-Board Interface Ports:

    a. Communications ports for each controller to allow direct connection to central operator workstation.
    b. Include operations such as downloading and uploading control programs, modifying programs and program database, and receiving trend reports, status reports, messages, and alarms.

12. Remote Workstation Interface Port:

    a. Direct connect personal computer port in each DDC system for permanent connection of remote central operator workstation.
    b. Operations possible by directly connecting personal computer to controller at highest level LAN available through this port.

13. Program Protection:

    a. Programs residing in memory protected either by using EEPROM or by uninterruptible power source (sealed battery back-up or uninterruptible power supply (UPS)).
    b. If backup power source is used, include sufficient capacity to maintain volatile memory in event of AC power failure.
    c. Where uninterruptible power source is rechargeable (a rechargeable battery), include sufficient capacity for 72 hour minimum back-up.
    d. Rechargeable power source constantly charged by charging circuitry while controller is operating under normal line power.
    e. Where non-rechargeable power source is used, include sufficient capacity for 2 year minimum accumulated power failure. Batteries designed to allow replacement without soldering.

14. DDC Controller Cabinet (Control Panel): NEMA 1, unless specified otherwise. Controller cabinets, or enclosures controller is mounted in, lockable with common keying door switch.
15. Hardware: Suitable for anticipated ambient conditions as follows:

    a. Controllers used outdoors and/or in wet ambient mounted within waterproof enclosures rated for operation at minus 40 F to 155 F.
    b. Controllers used in conditioned ambient spaces mounted in dust-proof enclosures rated for operation at 32 F to 120 F.

16. Spare Capacity: Include additional 10 percent minimum input/output (I/O) points, but not less than 1 spare point for each type. Include hardware for each point, installed and ready for external wiring.

D. Central Operator Workstation:

1. Description: Coordinate operation of District virtual P.C.

2.3 DIRECT DIGITAL CONTROL SYSTEM SOFTWARE

A. General:

1. Factory packaged, custom designed software to support command functions and application programs. Includes proportional, proportional plus integral, and proportional plus integral plus derivative (PID) action. User programmable.
2. Include software to modify control program database through hand held terminal, or keypad integral to controller.
3. Status Display:

    a. Current status of I/O and virtual points displayed on command.
    b. Associate points into functional groups, such as I/O and virtual points associated with control of a single air handling unit and displayed as a group.
    c. Group selectable from menu of groups having meaningful names, such as “AHU-4, SECOND FLOOR, CHILLER SYSTEM”.

4. Program Transfer: Software for download of control programs and database from higher level controllers and upload of same to higher level controllers. Each controller in DDC system capable of receiving downloads and delivering uploads through single controller on highest level LAN.
5. Diagnostics:

    a. Self-diagnostic routines for each DDC controller with messages to central operator workstation when errors are detected.
    b. Routine to recognize nonresponsive module on LAN. Remaining, responsive modules on LAN not to operate in degraded mode.

6. Power Loss: In event of power outage, each DDC controller assumes disabled status and outputs shall go to user definable state. Upon restoration of power, DDC system performs orderly restart with sequencing of outputs.
7. System shall include network management at controller level that includes support for wide area networks employing Internet Protocol (IP). Management services shall include BACnet Broadcast Management Device capabilities, I/P routing, and virtual networks in compliance with BACnet Standard Annex J.1.

B. Stand-Alone and Application Specific Controllers Software:

1. Function: To perform sequences of control and report to supervisory and global controllers.
2. Database Modification: Shall not require changes directly in line-by-line programming. When control program is line-by-line type, database parameters that take real number values require assignment of variable names so parameters can be changed without modifying line-by-line programming. Alternatively, include block programming languages for modification of these database parameters in fill-in-the-blank screens.

C. Supervisory and Global Controllers Software:

1. General: Include energy management and software required to support command functions and application programs. User programmable.
2. Function: To supervise stand-alone and application specific controllers and monitor and control HVAC equipment.

3. Database Modification:

    a. Include software to modify control program database. Accomplished through connected computer, hand held terminal, or keypad integral to controller.
    b. Database modification shall not require changes directly in line-by-line programming. When control program is line-by-line type, database parameters in the following list that take real number values require assignment of variable names so parameters can be changed without modifying line-by-line programming. Alternatively, include block programming languages for modification of these database parameters in fill-in-the-blank screens.
    c. The following shall be modifiable:

        1) Setpoints.
        2) Deadband limits and spans.
        3) Reset schedules.
        4) Switchover points.
        5) PID values and time between control output changes.
        6) Time.
        7) Timed local override time.
        8) Occupancy schedules.
        9) Holidays.
        10) Alarm points, alarm limits, and alarm messages.
        11) Point definition database.
        12) Point enable, disable, and override.
        13) Trend points, trend intervals, trend reports.
        14) Trend graphing capabilities for minimum of 100 points and 5000 samples for each point.
        15) Analog input default values.
        16) Calculated value adjust.
        17) Passwords.
        18) Communications parameters including network and telephone communications setups.

4. Differential: Equipment which is started and stopped or opened and closed in response to analog input such as temperature or pressure, include differential for control loop to prevent short cycling of equipment.
5. Motor and Flow Status Delay: Adjustable time delay between time motor is commanded on or off and when DDC system program looks to motor or flow status input to prevent nuisance alarms and confirm successful execution of command. Automatically adjust limit values to unoccupied parameters when in unoccupied mode.
6. Run-Time Accumulation: Resettable run-time accumulation for each controlled electrical motor.
7. Time Programs: Occupied-unoccupied time programs for start-stop and enable-disable with provisions for automatic adjustment for leap years, daylight savings time, and standard time.
8. Point Override: User override of I/O and virtual point setpoints, via software, with reset to any possible value over range of I/O device.
9. Calculated Point: Include ability to create point by calculating value from any combination of digital and analog point, input data, or other data.
10. Alarms: Include alarm capability for I/O points and virtual points. Alarm either enabled or disabled for every point. Alarm limits adjustable on analog points. Controllers connected to external device, such as a printer, terminal, or computer, to download alarm and alarm

messages when alarms occur. Otherwise, alarms stored and automatically downloaded when communications link occurs. The following conditions generate alarms:

a. Motor is commanded on or off but motor status input indicates no change.
b. Room temperature or pressure strays outside selectable limits.
c. Analog input shows value indicating sensor failure.
d. Module or controller not communicating with LAN.
e. Power outage occurs.

11. Messages: Operator defined and assigned to alarm points and displayed when point goes into alarm.
12. Trending:

a. Trend data capable of being uploaded to computer or available on real-time basis. Trend data appears either numerically or graphically on connected computer's screen as data is being processed from DDC system data environment.
b. Trend data automatically archived to selectable central operator workstation hard drive as historical trend data. Archive files appended with new data allowing data to be accumulated over several years.
c. Historical trend reports capable of being automatically generated from uploaded data from central operator workstation hard drive.
d. Trend data capable of being displayed graphically with control variable and process variable plotted as functions of time on same chart. Graphic display of trend data internal to central operator workstation software and not a capability resulting from download of trend data into a third-party spreadsheet program such as EXCEL, unless such transfer is automatic and transparent to operator and third-party software is included with central operator workstation software package.
e. At operator's discretion, trend data plotted real-time.
f. When trend memory is full, most recent data overwrite oldest data.

13. Password Protection: Include at least 4 levels of password protection for DDC system permitting minimum of 4 different levels of access to system. Include means to change passwords.

a. Passwords restrict user to only objects, applications, and systems functions as assigned by system manager.
b. User access secured using individual security passwords and user names.
c. User log on/log off attempts recorded.
d. System protects itself from unauthorized use by automatically logging off following delay time defined by system manager.

14. Application Programs:

a. General: Software programs to perform sequence of operations including, but not limited to, the following. Pre-tested and coordinated to insure that no conflicts or contentions remain unresolved.
b. Scheduling: Time-of-day, calendar based scheduling, holiday, and temporary schedule overrides.

1) Schedule Start/Stop Program: Each control output point scheduled for operation based on time-of-day, day-of-week, and day-of-year. Output points associated into groups. Each group associated with different

schedule. Changing schedule of group changes schedule of each point in group. Points may be added to and deleted from groups. Groups created and deleted by operator.

2) Capability to allow current schedules to be viewed and modified in 7 day week format.
3) Automatic determination of holidays.
4) Include operator adjustable time delay between consecutive start commands for electrical loads over 2.5 kW and 5 horsepower to eliminate power surges.
5) Minimum of 100 unique time schedules.

c. Optimum Start-Stop: Software to start and stop equipment on sliding schedule based on indoor and outdoor air temperature conditions. Include thermal characteristics of structure using prediction software to determine minimum time of HVAC system operation needed to satisfy space temperature requirements at start of occupied cycle and to determine earliest time for stopping equipment at day's end. Cycle equipment on and off during unoccupied period to maintain space temperatures at setback/setup conditions.
d. Occupied-Unoccupied Setpoint: Software to reset space temperature setpoints based on time-of-day for each day of week, including holidays. Warning and alarm limits automatically adjust accordingly.
e. Outside Air Temperature Cutoff: Software to automatically start and stop equipment in response to outside air temperature.
f. Economizer Override: Software to compare outdoor air and return air temperatures at each air handling fan system and select coolest airstream. If outdoor air temperature exceeds return air temperature, economizer cycle is overridden and dampers positioned to minimum outdoor air position.
g. Automatic Response: Software to control designated equipment based upon occurrence of high or low limit violations of digital or analog values.
h. Automatic Reset: Software to intelligently reset control points in response to changing conditions. Include ability to control DDC setpoints, control point adjust adjustment points, and analog output points.
i. Equation Processing (User-Defined Programs): Software to allow user to create custom routines to perform calculations which act upon data in database.

D. Central Operator Workstation Software:

1. General: Provide compatible with District's existing system.

2.4 NETWORK AND NETWORK COMMUNICATIONS

A. General: DDC system communications capability via local area network (LAN), automatic dial-up telephone line modem connection, and internet connection.

B. Local Area Network (LAN):

1. Central Operator Workstation/DDC System Panel Support: Central operator workstation and DDC controllers directly reside on single shared high speed LAN such that communications may be executed directly between DDC controllers.
2. Dynamic Data Access: Operator devices, either network resident or connected remotely, via dial-up modems, with ability to access point status and application report data, or

execute control functions for other devices via LAN. Access to data based upon logical identification of building equipment. Access to system data not restricted by hardware configuration. Network hardware configuration transparent to user when accessing data or developing control programs.

3. High Speed Data Transfer Rates: Alarm reporting, quick report generation from multiple DDC controllers, and upload/download efficiency between network devices.
4. LAN Support: Any combination of DDC controllers and central operator workstation directly connected to LAN. LAN self-configuring to automatically re-configure as nodes are added or removed.
5. Failures: Detection and accommodation of single or multiple failures of DDC controllers, network media, or central operator workstation. Include provisions for automatically re-configuring to allow operational equipment to perform their designated functions as effectively as possible in event of single or multiple failures.
6. Message and Alarm Buffering: To prevent information from being lost.
7. Error Detection, Correction, and Re-Transmission: To ensure data integrity.
8. Components: Commonly available, multiple source, to allow DDC system to coexist with other networking applications. Ethernet is preferred technology.
9. Communications: Deterministic nature to assure calculable performance under worst-case network loading. When collision-based network is proposed, include detailed calculations showing worst-case network response times.
10. Automatic Synchronization: Include for real-time clocks in DDC controllers.

C. Automatic Dial-Up Communications:

1. General: Auto dial/auto answers communications to allow controllers to communicate with central operator workstation on intermittent basis via telephone lines.
2. DDC Controllers: Auto-dial function to automatically place calls to central operator workstation to report critical alarm or to upload trend and historical information for archiving.

    a. Communications software to analyze and prioritize alarms to minimize initiation of calls. Non-critical alarms buffered in memory and reported as group of alarms or until operator manually requests upload of alarms.
    b. Auto dial program provisions for handling busy signals, “no-answers”, and incomplete data transfers. Default devices called when communications cannot be established with primary devices.

3. Central Operator Workstation: Dial-up program software to perform control functions, report functions, and database generation and modification functions as described for workstation connected via LAN. Routines to automatically answer calls and either file or display information sent from DDC controllers.

    a. Ability to access remote buildings by selection of any facility by its logical name or graphic. Ability to maintain user definable cross-reference of buildings and associated telephone numbers, so that user does not need to remember or manually dial telephone numbers.
    b. Central operator workstation may serve as operator device on LAN, as well as dial-up workstation for multiple auto-dial DDC controllers and networks. Alarm and data file transfers handled via dial-up transactions shall not interfere with LAN activity, nor shall LAN activity keep workstation from handling incoming calls.

D. Internet Communications: Allows communication with DDC controllers via Internet or Intranet using either Microsoft Internet Explorer or Netscape web browsers.

E. Speed: If system architecture consists of low level (controller-to-controller) and high level (controller-to-central operator workstation) LAN, minimum rate for lowest level LAN shall be 14.4 MBaud and minimum rate for the highest level LAN shall be 2.5 MBaud. Minimum rate for DDC system consisting of single LAN shall be 14.4 MBaud.

F. Expansion: Include ability to expand or modify network either via LAN, auto-dial telephone line modem connections, or combination of networking schemes.

2.5 SENSING AND CONTROL HARDWARE

A. Temperature Sensors:

1. General:

a. Description: Thermistor type for temperature sensing applications below 200 F, 10K Ohms.
b. Accuracy: Minimum plus or minus 0.7 F over a range of 32 F to 150 F unless otherwise specified.
c. Element and Leads: Encapsulated. Bead thermistors not acceptable.
d. A/D Conversion Resolution Error: Less than or equal to 1 percent.
e. Total Error for Thermistor Circuit: Not to exceed 0.5 F, which includes sensor error and DDC controller A/D conversion resolution error.
f. Cable: 18 gauge twisted or shielded.

2. Room Temperature Sensor:

a. Accuracy: Plus or minus 1 F.
b. Integral push-button for digital input to controller for system override.
c. Setpoint adjustment with preset limits.
d. Analog input to DDC controller.
e. Digital thermometer.
f. Cover color off-white or beige as selected by the A/E.
g. Flush flat panel for installations in corridors, toilet rooms, locker rooms, gymnasiums, cafeteria, library, and other high impact areas and where indicated on the Drawings.

3. Duct Temperature Sensor:

a. Accuracy: Plus or minus 1 F.
b. Duct Averaging Type: Continuous averaging type for ductwork applications, 2 foot length for each 4 square feet of ductwork cross-sectional area with 6 foot minimum length.
c. Probe Type: One foot length minimum for ducts 3 foot square and less. Spot sensor if cross-sectional area is less than 18 square inch and for VAV and FTU discharge temperature.

4. Outside Air Temperature Sensor:

a. Accuracy: Plus or minus 3 F.
b. Stainless steel encased, mounted with watertight fittings.
c. Shield consisting of a 0.080 inch minimum sheet aluminum enclosure to protect sensing element from snow, ice, and rain. Shield designed to allow free flow of ambient air across sensing element.

B. Immersion Temperature Sensor:

1. Accuracy: Plus or minus 1 F.
2. Insertion type, stainless steel encased, matched with thermal well installed.
3. Thermal wells Monel, brass, or copper for use in copper water lines, and Type 316 stainless steel for other applications.
4. Thermal wells 3 inch long for pipe sizes 4 inch and smaller and 6 inch long for pipe sizes 6 inch and larger.
5. Provide heat-sensitive transfer agent between exterior sensor surface and interior well surface.

C. Pipe Surface Temperature Sensor:

1. Used to measure water temperature in existing pipe.
2. Platinum resistance temperature detector (RTD) consisting of miniature ceramic body with embedded thin film chip, adhered to pipe with epoxy for permanent mounting. Include matched temperature transmitter to convert RTD signal to 4 to 20 mA current loop scaled proportional to range of transmitter, and conduit mounting box.

D. Carbon Dioxide (CO_2) Sensors:

1. Designed for demand controlled ventilation to measure atmospheric and room CO_2 levels and transmit signals to DDC system.
2. 5-year self-calibration.
3. Sensing range 0 to 2000 ppm.
4. Accuracy plus or minus 30 ppm plus 2 percent of reading, including nonlinearity and calibration uncertainty.
5. Non-linearity less than plus or minus 1 percent of full scale.
6. Long term stability less than 5 percent of full scale over 5 years.
7. 1 minute response time.
8. 4 to 20 mA or 0 to 10 V DC output signal.
9. Wall mounted or duct mounted as indicated on the Drawings.
10. Include calibration kit.
11. Manufacturers: Vaisala CARBOCAP® Transmitter Series GM20, SenseAir® Model aSENSE-k Series, Telaire, AirTest™ Technologies Inc., or approved.

E. Indoor Air Quality (IAQ) Sensors:

1. Device shall measure amount of volatile organic compounds (VOC) present and control amount of outside air entering conditioned space.
2. Supply voltage 24 V AC.
3. Capability to reset output to less than factory setting of 0 to 10 V DC with no effect on output's resolution.
4. Two outputs, 1 dampered (PI) and 1 undampered (immediate). Undampered output field adjustable. Dampered output shall control damper actuator.

5. Wall mounted, duct mounted, or mounted within duct as indicated in the Contract Documents. Duct mounted sensors with sintered filter and be velocity independent.
6. Manufacturers: Global Controls, Inc. AQS, Triatec, Teletrol Systems Inc., Building Automation Products, Inc., or approved.

F. Thermostats:

1. Electric Room Thermostats:

   a. Provide District's standard equipment.

2. Line Voltage Room Thermostats:

   a. Single or two-pole rated for resistance or motor load.
   b. Cover: Locking type with setpoint adjustment with thermometer.

3. Duct Thermostats:

   a. Remote bulb or bimetallic rod and tube type, proportional action with adjustable setpoint in middle of range and adjustable throttling.
   b. 7-1/2 foot averaging service remote bulb element.

4. Outside Air Thermostats:

   a. Remote bulb or bimetal rod and tube type proportioning action with adjustable throttling range and setpoint.
   b. Minus 10 to plus 120 F scale range.
   c. Shield consisting of a 0.080 inch minimum sheet aluminum enclosure to protect thermostat from snow, ice, and rain. Shield designed to allow free flow of ambient air across the sensing element.

G. Transmitters:

1. General:

   a. Output 4 to 20 mA or 2 to 10 V AC, linearly scaled to temperature, pressure or flow range being sensed.
   b. Total error not to exceed 0.1 percent of 20 mA (0.02 mA) at any point across 4 to 20 mA span.
   c. Supply voltage 24 V AC or 24 V DC.
   d. Noninteractive offset and span adjustments.
   e. Spans and Ranges - Temperature:

      1) 50 F Span: Room, chilled water, cooling coil discharge air, and return air sensors.
      2) 100 F Span: Outside air, domestic hot water, heating coil discharge air, and mixed air sensors.
      3) 200 F Span: Heating water and combination chilled heating water system sensors.

   f. Spans and Ranges - Pressure:

1) Minus 0.1 to Plus 0.1 inch of Water Differential Range: Room static pressure control.
2) Minus 1.0 to Plus 1.0 inch of Water Differential Range: Duct, filter, or fan static pressure.
3) 0 to 5 inch of Water Differential Range: Duct or fan static pressure.
4) 0 to 100 psig Differential Range: Water differential pressure to suit application.

2. Temperature Transmitters:

a. Consist of combination temperature sensors and transmitters. Match each transmitter to its temperature sensor.
b. Factory calibrated and sealed.

H. Differential Air Pressure Transmitter:

1. Device with integral pressure transducer and transmitter. Include offset and span adjustments.
2. Sensing element either capsule, diaphragm, bellows, Bourden tube, or solid state.
3. Rated for 150 percent of working pressure.
4. Accuracy plus or minus 1 percent corresponding to pressure span.
5. Linearity 0.1 percent.
6. Output 4 to 20 mA signal proportional to pressure span.
7. Supply voltage 24 V AC or 24 V DC.

I. Differential Air Pressure Switches:

1. Diaphragm or bourden tube sensor.
2. Rated for 150 percent of working pressure.
3. Repetitive accuracy plus or minus 2 percent of operating range.
4. Switch actuation adjustable over operating pressure range in accordance with NEMA ICS 1.
5. Snap action Form C contact rated for application.

J. Differential Static Pressure Switches:

1. Diaphragm type differential static pressure switch for binary (two-position) operation.
2. Rated for pressure surges to 150 percent of peak application pressure.
3. Repetitive accuracy plus or minus 1 percent.
4. Range selected for operating pressure trip point of approximately midpoint of pressure switch adjustable range.
5. Snap action Form C contact and switch rated for application, wired for normally open or normally closed operation.
6. Adjustable trip setpoint.

K. Low Temperature Protection Switches (Freezestat):

1. Capillary type electric temperature actuated switch.
2. Special purpose insertion thermostats with flexible elements minimum 20 feet in length for coil face areas up to 40 square feet. Include additional or longer elements for larger coils at rate of 1 foot length of element for each additional 1.5 square feet of coil.

3. Factory made radius turning guide for changes in direction that element makes in serpentine configuration.
4. Freezing condition at 12 inch increments along sensing element activates thermostatic switch.
5. Adjustable setpoint.
6. Manual reset after activation.
7. Switch contacts rated for motor starter circuit voltage being interrupted.
8. Switch equipped with auxiliary set of contacts for input of switch status to DDC system.

L. On/Off Switches: Wall mounted, single pole type with illuminated switch to indicate that controlled item is operating. Include stainless steel cover and nameplate.

M. Three-Position Switches: Wall mounted, center off position, number of poles and throws to suit application. Include stainless steel cover with engraved switch positions. Include nameplate.

N. Door Switch: For concealed installation in door jamb with pushbutton so that opening door causes switch action.

O. Multi-position Control Panel Switch: Wall mounted, push button, number of buttons to suit application, illuminated when on, provide with legend/labeling plate. Allen Bradley Bulletin 800H or approved.

P. Emergency Shut Down Switch: Mushroom head, wall mounted, color red, non-spring return, illuminated when on. Provide labeling- “EMERGENCY SHUT DOWN FOR _____”. Allen Bradley Bulletin 800H or approved.

Q. Current Transducers (Current Sensing Relays):

1. Designed to monitor amperage of motors.
2. Range for normal amperage to be above 50 percent of range.
3. Accuracy 1 percent of full scale.
4. Analog output signal 4 to 20 mA.
5. Indicate whether normally open or normally closed.
6. Trip-point approximately midpoint of switch adjustable range. Adjust relay switch point so that relay responds to motor operation under load as an “on” state and so that relay responds to unloaded running motor as an “off” state. Motor with broken belt is considered an unloaded motor.
7. Limit off-state leakage to 2 mA or less.

R. Airflow Measuring Units (AMU), Thermal/Electronic Type:

1. Description: Station with array of velocity sensing elements for mounting in:

   a. Ducts, plenums, and outside air intakes and station with array of airflow sensing probes designed for mounting inside fan inlet bellmouth. Unit listed and labeled as assembly in accordance with UL 873. Vortex shedding and differential pressure measuring devices not acceptable.

2. Application:

a. Ducts, plenums, and outside air intakes shall consist of 1 or more multi-point airflow measuring probes and single microprocessor-based transmitter. Number of sensor nodes depend on duct area where installed
b. Fan inlet shall consist of 1 or 2 probes, each with single sensor and single microprocessor-based transmitter.

3. Each sensing point shall independently determine airflow rate which shall be equally weighted and averaged by transmitter prior to output. Devices which average multiple non-linear sensing point signals not acceptable.
4. Laboratory accuracy of plus or minus 2 percent of reading over entire operating airflow range. Unit factory wind tunnel calibrated or verified against reference standards directly traceable to NIST.
5. Installed accuracy, when installed in accordance with manufacturers guidelines, without field adjustment as follows throughout operating airflow range:

a. Ducts and Plenums: Plus or minus 3 percent of reading.
b. Outside Air Intakes: Plus or minus 5 percent of reading.

6. Fan Inlets: Plus or minus 10 percent of reading. Velocity sensing elements glass-in-bead thermistor type.
7. Station construction suitable for operation to:

a. 5,000 fpm velocity for ducts, plenums, and outside air intakes.
b. 10,000 fpm for fan inlets.

8. Operating temperature range for measuring probes minus 20 F to 140 F.
9. Operating humidity range for measuring probe 0 to 99 percent relative humidity (non-condensing).
10. Transmitter:

a. Include 16-character alpha-numeric LCD to display airflow as velocity or volumetric airflow rate, temperature, airflow alarm, and system status alarm.
b. Capable of communicating with DDC system specified in this Section with the following interface options:

1) GTC: Two isolated analog output signals (field-selectable/scalable 0 to 5, or 0 to10 V DC or 4 to 20 mA) plus one isolated RS-485 network connection (field-selectable BACnet MS/TP or Modbus RTU).
2) GTM: Two isolated analog output signals (field-selectable/scalable 0 to 5 or 0 to10 V DC or 4-20 mA) plus one isolated Ethernet network connection (simultaneously supported BACnet Ethernet, BAC-net IP, Modbus TCP or TCP/IP).
3) GTL: One isolated LonWorks® Free Topology network connection.
4) GTD: One USB connection for thumb drive data-logging of sensor airflow and temperature over specified time intervals.

c. Include analog output signals for total airflow rate and be field configurable to output for 1 of the following:

1) Temperature,
2) Airflow alarm,
3) System status alarm, or

4) Individual fan alarm (fan inlet AMU only).

d. Include serial communications for average airflow rate, temperature, airflow alarm, system status alarm, individual sensor node airflow rates, and individual sensor node temperatures.
e. Include infra-red I/O card mounted on transmitter PCB for communication to handheld retrieval device to download individual sensor node airflow and temperature data in real time.
f. Include “watchdog” timer circuit to ensure continuous operation in event of brown-out and power failure.
g. Operating temperature range minus 20 F to 120 F. Protect transmitter from weather and water.
h. 24 V AC powered. Inputs internally isolated. Both inputs and outputs with duty fault protection.

11. Manufacturers:

a. For ducts, plenums, and outside air: Ebtron Model GTx116-P+ or approved.
b. For fan inlets: Ebtron Model GTx108-F or approved.

2.6 CONTROLLED HARDWARE

A. Motorized Dampers, Square and Rectangular, Thin Line:

1. Description: Airfoil blade, low leakage type.
2. Performance: Maximum allowable leakage of 6 cfm per square foot of damper face area at 4 inch w.g. pressure difference as tested in accordance with AMCA Standard 500-D and certified for air performance and air leakage performance per AMCA 511.
3. Construction:

a. Blades: Four inch maximum blade width, airfoil shape, extruded aluminum.
b. Frame: Extruded aluminum.
c. Bearings: Corrosion resistant, molded synthetic or nylon.
d. Seals: Extruded vinyl or stainless steel on blade edge suitable for operating temperature range of minus 72 F to 275 F, flexible metal compression type at jamb.
e. Linkage Hardware: Concealed in frame, aluminum or corrosion resistant zinc and nickel plated steel construction linkage assembly and mountings for 1 damper actuator per each 20 square feet of damper face area.
f. Axles: Plated steel, hexagonal.
g. Control Shaft: Removable, 1/2 inch diameter, plated steel. Positive locking mechanism to actuator. Factory installed jackshaft for multiple Section dampers.

4. Blade Type: Opposed blade for modulating control and parallel blade for two-position control. Parallel blade for air handling unit mixing dampers as specified in Section 233400.
5. Manufacturers: Ruskin Company CD40, NCA Manufacturing, Inc., Pacific Air Products, American Warming and Ventilating Co., Nailor Industries Inc., Honeywell Commercial Building Controls, or approved.

B. Motorized Dampers, Square and Rectangular, Low Leakage:

1. Description: Airfoil blade, AMCA Class 1A leakage rated type.
2. Performance: Maximum allowable leakage of 3 cfm per square foot of damper face area at 1 inch w.g. pressure difference as tested in accordance with AMCA Standard 500-D and certified for air performance and air leakage performance per AMCA 511.
3. Construction:

    a. Blades: Six inch maximum blade width, airfoil shape, galvanized steel.
    b. Frame: Galvanized steel hat channel with corner braces.
    c. Bearings: Stainless steel, permanently lubricated.
    d. Seals: Extruded vinyl or stainless steel on blade edge suitable for operating temperature range of minus 72 F to 275 F, flexible metal compression type at jamb.
    e. Linkage Hardware: Concealed in frame, aluminum or corrosion resistant zinc and nickel plated steel construction linkage assembly and mountings for 1 damper actuator per each 20 square feet of damper face area.
    f. Axles: Plated steel, hexagonal.

4. Blade Type: Opposed blade for modulating control and parallel blade for two-position control. Parallel blade for air handling unit mixing dampers as specified in Section 233400.
5. Manufacturers: Ruskin Company CD60, NCA Manufacturing, Inc., Pacific Air Products, American Warming and Ventilating Co., Nailor Industries Inc., Honeywell Commercial Building Controls, or approved.

C. Motorized Dampers, Round:

1. Description: Butterfly type, low leakage type.
2. Performance: Maximum allowable leakage of 0.15 cfm per inch of perimeter at 4 inch w.g. pressure difference as tested in accordance with AMCA Standard 500-D and certified for air performance and air leakage performance per AMCA 511.
3. Construction:

    a. Blade: Two layers of galvanized steel for 14 gage equivalent thickness.
    b. Frame: Galvanized steel with rolled stiffener heads.
    c. Bearings: Stainless steel sleeve pressed into frame.
    d. Seals: Polyethylene foam sandwiched between 2 sides of blade.
    e. Control Shaft: 1/2 inch diameter, plated steel. Positive locking mechanism to actuator.

4. Manufacturers: Ruskin Company CDRS25, NCA Manufacturing, Inc., Pacific Air Products, American Warming and Ventilating Co., Nailor Industries Inc., Honeywell Commercial Building Controls, or approved.

D. Control Valves, Hydronic Modulating, General Application:

1. Application: Coils in air handling units, multizone units, fan coil units with flow rates greater than 10 gpm.
2. Configuration: Globe style with plug, two-way or three-way mixing type as indicated on the Drawings. Three-way butterfly and three-way ball valves not acceptable. Belimo Aircontrols (USA), Inc. characterized control valve acceptable.
3. Characteristics: Equal percentage.

4. Sizing: Cv as indicated on the Drawings. If not indicated, size for pressure drop of 4 psig at design flow rate. Actual pressure drop at design flow rate not less than 75 percent nor greater than 125 percent of specified pressure drop.
5. Standards: ASME B16.5 for bronze or steel valves, ASTM A 126 Class B or C for cast iron valves.
6. Working Pressure Rating: 125 psig SWP or 150 percent of system operating pressure, whichever is greater.
7. Shut-off Pressure Rating: 50 psig differential pressure across valve.
8. Temperature Rating: Minimum continuous operating temperature of 250 F.
9. Leakage Rating: 0.01 percent of design flow rate at specified pressure drop.
10. Body:

    a. 1 1/2 inch and Smaller: Brass or bronze with threaded or union ends.
    b. 2 inch: Brass, bronze, cast iron, or steel with threaded ends.
    c. 2 1/2 inch and 3 inch: Brass, bronze, cast iron, or steel with flanged ends.
    d. 4 inch and Larger: Cast iron or steel with flanged ends.

11. Trim: Brass, bronze, or Type 316 stainless steel.
12. Stem: Type 316 stainless steel.

E. Control Valves, Hydronic Modulating, Terminal Equipment:

1. Application: VAV unit and FTU coils, fan coil units and unit heaters. Flow rate 10 gpm and less.
2. Configuration: Ball valve, two way.
3. Characteristics: Equal percentage.
4. Sizing: Size for pressure drop of 4 psig at design flow rate. Actual pressure drop at design flow rate not less than 75 percent nor greater than 125 percent of specified pressure drop. Size valve taking into consideration both pressure drop of valve and added pressure drop incurred when reducing down from line the size to control valve size (adjustment of Cv for piping geometry factor, Fp.). Valve size no more than 2 sizes smaller than line size.
5. Standards: ASME B16.5.
6. Working Pressure Rating: 600 psig WOG, cold, non-shock.
7. Shut-off Pressure Rating: 50 psig differential pressure across valve.
8. Temperature Rating: Minimum continuous operating temperature of 250 F.
9. Leakage Rating: 0.01 percent of design flow rate at specified pressure drop.
10. Body, 2 inch and Smaller: Bronze body, two piece construction, threaded ends.
11. Trim: Stainless steel ball and stem, reinforced TFE seats, and high performance graphite impregnated stem seals. Standard RTFE stem seals not acceptable.
12. Stem Design: Blow-out proof, stem packing gland adjustable to compensate for wear.
13. Testing: Each valve tested with air under water at each end of travel by manufacturer.
14. Actuator Brackets: Metallic, designed to minimize heat transfer from valve to actuator.

F. Control Valves, Hydronic Isolation (Two-Position), Ball Type:

1. Configuration: Ball valve, two-way.
2. Sizing: Full line size.
3. Standards: ASME B16.5.
4. Working Pressure Rating: 600 psig WOG, cold, non-shock.
5. Shut-off Pressure Rating: 50 psig differential pressure across valve.
6. Temperature Rating: Minimum continuous operating temperature of 250 F.

7. Leakage Rating: 0.01 percent of design flow rate at 1 psig pressure drop.
8. Body, 2 inch and Smaller: Bronze body, two piece construction, threaded ends.
9. Trim: Stainless steel ball and stem, reinforced TFE seats, and high performance graphite impregnated stem seals. Standard RTFE stem seals not acceptable.
10. Stem Design: Blow-out proof, stem packing gland adjustable to compensate for wear.
11. Testing: Each valve tested with air under water at each end of travel by manufacturer.
12. Actuator Brackets: Metallic, designed to minimize heat transfer from valve to actuator.

G. Control Valves, Hydronic Isolation (Two-Position), Butterfly Type:

1. Configuration: Butterfly valve, two-way.
2. Sizing: Full line size.
3. Standards: ASTM A 126, Class B or C.
4. Working Pressure Rating: 175 psig or 150 percent of system operating pressure, whichever is greater.
5. Shut-off Pressure Rating: 50 psig differential pressure across valve.
6. Temperature Rating: Minimum continuous operating temperature range of minus 20 F to plus 250 F.
7. Leakage Rating: 0.01 percent of design flow rate at 1 psig pressure drop.
8. Body: Ductile iron, threaded lug style, flanged piping connections.
9. Trim: Noncorrosive disks, EPDM seats.
10. Stem: Stainless steel support by bearing.
11. Neck: Length sufficient for pipe insulation thickness specified in Section 230700.
12. Manual Actuation: Handwheel with operation independent of electric actuator.

H. Electric Actuators:

1. Description: Direct drive (direct shaft mounted) electric actuators for valve and damper control applications.
2. Positive means of preventing slippage of actuated device shaft.
3. UL listed and labeled with NEMA 2 enclosure.
4. When operated at rated voltage, capable of delivering torque required for continuous uniform movement of valve or damper.
5. Include end switch or built-in electronic control feature to limit travel and to withstand continuous stalling without damage.
6. Proper function with range of 85 to 110 percent of line voltage.
7. Fiber or reinforced nylon gears may be used for torques less than 16 inch pounds.
8. Mechanical spring return for outside air dampers, exhaust air dampers, heating water control valves, and steam control valves. Other applications as indicated on the Drawings.
9. Proportioning operators capable of stopping at points in cycle and starting in either direction from any point.
10. Normally open and normally closed as indicated on the Drawings to result in valve or damper position under failure of control power to device.
11. Electric actuator auxiliary switches to indicate open/closed status. Calibrate with remote monitoring/control function.
12. For modulating valve and damper actuators, include position feedback via 2 to 10 V DC analog output feedback signal suitable for wiring to analog input point in DDC system. “Modulating” is defined as analog control. Floating point actuator not acceptable.
13. For multiple actuators controlled from a single output signal, include cascading signal relationship via “master-slave” wiring to ensure damper assembly is responding to input signal.
14. Manufacturers: Belimo Aircontrols (USA), Inc. No substitutions.

15. Manufacturers of Actuators for Flow Control Valve Assemblies or Pressure Independent Flow Control Valves Specified in Section 232113:

    a. Flow Control Valve Assemblies: Griswold Controls®, Belimo Aircontrols (USA), Inc., Honeywell Commercial Building Controls, Invensys Building Systems, Inc., Johnson Controls, Inc, KMC Controls, Neptronics®, or Siemens Building Technologies.
    b. Pressure Independent Flow Control Valves:

        1) Griswold Controls® Valves: Belimo Aircontrols (USA), Inc., Honeywell Commercial Building Controls, Invensys Building Systems, Inc., Johnson Controls, Inc, KMC Controls, Neptronics®, or Siemens Building Technologies.
        2) Flow Controls Industry, Inc. DeltaPValve: Contact valve manufacturer at 425-483-1297 for actuator manufacturers.

I. Natural Gas and Water Measuring Devices:

1. General: Integrate natural gas and water meter signals into DDC system. Coordinate with meters specified in Division 02 and Sections 221116 and 231123.

J. Electric Consumption Measuring Devices:

1. General: Provide kilowatt-hour (KWh) meter for building. Integrate electric meter signal into DDC system. Coordinate and furnish output devices for meters for electrical consumption and demand. Coordinate with meters specified in Division 26.
2. Meter:

    a. Comply with IEEE C12.10.
    b. Watt-hour meter and socket corresponding to ratios of current transformers and transformer secondary voltage.
    c. Select for 208 or 480V, three-phase, 4-wire wye/Delta system, three-element type with three current transformers.
    d. Box mounted socket having automatic circuit closing bypass.
    e. Four or more pointer-type kWh registers, provisions for pulse initiation, and universal Class 2 indicating maximum kW demand register, sweep pointer indicating type, with 15 minute interval.
    f. Meter accuracy plus or minus 1 percent.
    g. Include correct multiplier on face of meter.

3. Current Transformers:

    a. Comply with IEEE C57.13.
    b. Three current transformers with 600 V insulation, rated for metering with voltage, momentary, and burden ratings coordinated with ratings of the associated meters.
    c. Butyl molded donut or window type transformer mounted on bracket to allow secondary cables to connect to transformer bushings.
    d. Identify wiring of current transformer secondary feeders to permit field current measurements to be taken with hook-on ammeters.

2.7 VARIABLE FREQUENCY DRIVES (VFD)

A. General: Comply with requirements in Section 230915. VFDs shall be furnished as part of this section. Multiple manufacturers not acceptable.

2.8 FIRE ALARM DEVICES

A. Description: Complete functionality of fire alarm devices is included in this section. Duct smoke detectors as required by IMC. UL listed and labeled and FM approved detectors for duct installation. Coordinate electrical/mechanical interface with Division 28.

B. Smoke Control: Comply with Division 28 requirements. Fan shutdown and combination fire/smoke damper control are accomplished by the fire alarm system. Refer to the Contract Documents for specific details of DDC system interface.

C. Duct Smoke Detectors: Furnished under Division 26 work and installed under Section 233100. Coordinate fire alarm system shutdown of HVAC systems with Division 28.

2.9 AUXILIARY COMPONENTS

A. Control Panels:

1. NEMA 1, hinged door with nameplate, key locking with single key to operate all locks, logically assembled at one or more locations.
2. Include terminal strips with 25 percent spare capacity for external connections.
3. Push buttons, maintained contact type, spring return. Contacts rated minimum 10 Amps at 120 V.
4. Record control drawings secured to inside of panel door, enclosed in plastic jackets, for each system at each panel.
5. Laminated engraved plastic labels at interior control devices on panel (not on the device) for identification in conjunction with record control drawings. Include device number, its normal operation, and setpoint (example, “TC-7, DIRECT-ACTING, 60 F, RESET”). Include reset schedules for devices with reset.
6. Coordinate electrical power supply with work of Division 28. Include single 120 V, 15 Amp service to each panel.

B. Nameplates and Tags:

1. Laminated engraved plastic or brass nameplates for equipment and devices.
2. Identify equipment name by function, such as “COLD DECK TEMPERATURE”, and point identification number as shown on record control drawings as plain text device description, such as “SPS-18 STATIC PRESSURE SENSOR”.
3. Laminated plastic 1/8 inch thick, black and white letters.
4. Minimum size 1 inch by 3 inch, with minimum of 3/8 inch high engraved block lettering.

C. Remote Shutdown Switch for Gas Automatic Shut-Off Valves: NEMA 1 rating, surface mounted, maintained pushbutton type with red color button. Include contact block with 1 N.O. and 1 N.C. contacts, clear plastic hinged cover, and engraved nameplate on wall stating “REMOTE GAS SHUT-OFF SWITCH”.

D. Smoke Damper Indication: Furnish local remote indication of blade damper position by means of recessed mounted junction box with engraved nameplate having “RED” (for closed) and “GREEN” (for open) LEDs.

2.10 ELECTRIC POWER AND DISTRIBUTION

A. Source: 120 V or less, 60 Hz, two-pole, 3 wire with ground. Devices UL listed and labeled or FM approved. Coordinate with Division 26.

B. Transformers:

1. Limited energy type step down type with capacity to operate simultaneously connected apparatus with 25 percent overload for 1 hour.
2. Comply with UL 506.
3. Supply AC electrical power to DDC controllers specified in this Section on highest level LAN from dedicated circuit breakers. Transformers for DDC controllers serving terminal equipment on lower level LANs may be fed from fan motor leads, or fed from the nearest distribution panel board or motor control center, using circuits provided for the purpose.
4. Coordinate with Division 26.

2.11 CONTROL WIRING

A. General:

1. Include wire and cable not shown on electrical drawings as required for complete and operable control system including wiring to transformer primaries.
2. Conform to NEC and Division 26 requirements.
3. Circuits operating at more than 100 V in accordance with Division 26.
4. Circuits operating at 100 V or less defined as low voltage and run in rigid or flexible conduit, metallic tubing, metal raceways or wire trays, armored cable, or multiconductor cable.
5. Include transformers to supply power for low voltage circuits.
6. Use multiconductor cable for concealed accessible locations only.
7. Include circuit and wiring protection as required by NFPA 70.
8. Provide printed labels at controllers identifying connected devices with name and number. Device numbers only not acceptable.

B. Control Wiring:

1. Copper No. 18 AWG minimum with 300 V insulation, stranded.
2. Wire used for analog functions twisted and shielded, 2, 3, or 4 wire to match analog function hardware.
3. Copper No. 16 AWG within control panels for binary outputs and pilot relay.
4. Multi-conductor wire with outer PVC jacket.
5. Insulation rating for control wiring installed in control panels and other enclosures with power circuit conductors no less than that for power circuit conductors.

C. Sensor Wiring:

1. Copper No. 20 AWG minimum, stranded, twisted and shielded, 2, 3, or 4 wire to match analog function hardware, with No. 20 AWG drain wire. Exception: Direct connect RTD wiring single No. 18 AWG minimum twisted pair, 100 percent shielded with No. 20 AWG drain wire.
2. Multi-conductor wire with outer PVC jacket.

D. Aluminum Wiring: Not acceptable.

E. Surface Raceway: For sensor and control wiring in finished spaces where “fishing” in walls is not possible. Wiremold, Panduit, or approved.

F. Line Voltage Wiring: Wiring for 120 V single conductor, copper No. 14 AWG minimum, rated for 600 V service.

G. Plenum Cable: UL listed and labeled for plenum use.

2.12 CARBON MONOXIDE (CO) DETECTION AND CONTROL SYSTEM

A. Description: Electrochemical type, wall mounted, factory assembled sensor with LCD display and integrated set point and alarm relays. 12 to 30 V DC or 24 V AC input via field furnished separate transformer. 4 to 20 mA or 0 to 5 V DC output signal. Sensor certified to meet UL 2034.

B. Components:

1. Liquid crystal display with CO in ppm and set-up menu.
2. Form A, programmable, alarm exposure relay.
3. Form B, programmable, set point relay.
4. Green LED for normal condition, Yellow LED for relay, and Red LED for alarm.
5. Ninety dB Piezo transducer audible exposure relay for 30 minutes.
6. Operating range minus 10 C to 60 C, 5 to 99 percent relative humidity (non-condensing).
7. NEMA 1 polycarbonate plastic enclosure.

C. Sensor Performance:

1. Plus or minus 2 percent reproducibility
2. Sixty seconds at 90 percent reading response time.
3. Less than plus or minus 5 percent per year stability.
4. Five year life expectancy.

D. Manufacturers: Senva® CO-EC-W-A or approved.

2.13 HYDRONIC FLOW AND BTU METER SYSTEM

A. Flow Meters:

1. In-line electromagnetic type with integral transmitter
2. Housing epoxy coated carbon steel flow tube with PTFE liner.
3. Flanges ANSI Class 150.
4. Type 16 stainless steel sensing electrodes.

5. Media temperature range 0 F to 212 F
6. Ambient temperature range 14 F to 122 F.
7. Meter with 16 character, 8 line alphanumeric LCD display for flow rate and velocity, flow direction and totals, and short term data, and error messages.
8. Isolated 4 to 20 mA analog output for flow rate and 2 programmable digital/pulse outputs (configurable for frequency, pulse, or directional flow).
9. Accuracies:

    a. Plus or minus 0.4 percent of reading from 3.3 to 33 fps.
    b. Plus or minus 0.75 percent of reading from 1 to 3.3 fps.
    c. Plus or minus 0.0075 fps at flows less than 1 fps.

10. Manufacturer: ONICON Incorporated F-3100 Series or approved.

B. BTU Meter:

1. Package matched with flow transmitter by same manufacturer. Include matched pair of temperature sensors and stainless steel thermal wells.
2. Meter factory programmed and capable of being re-programmed using front panel keypad.
3. Temperature sensors bath-calibrated and matched (NIST traceable) for specific temperature range.
4. Include output points to integral LCD and to DDC system specified in this section for total energy, energy rate, flow rate, supply temperature, and return temperature.
5. Output signals serial network (protocol conforming to BACnet® MS/TP, BACnet/IP, LonWorks®, JCI-N2, Modbus RTU/RS 485, Modbus TCP, or Siemens-PI) or via individual analog and pulse outputs.
6. Manufacturer: ONICON System-10 or approved.

2.14 SURGE PROTECTION FOR DDC SYSTEMS

A. Description: Surge and transient protection devices installed externally to DDC controllers.

B. Power Line Surge Protection: Do not use fuses for surge protection. Include surge suppresser on incoming AC power. Comply with UL 1449 and IEEE. Clamping voltage ratings below the following levels:

1. Normal Mode (Line to Neutral): 350 Vs.
2. Common Mode (Line to Ground): 350 Vs.

C. Telephone and Communication Line Surge Protection:

1. Metal oxide varistor (MOV) protection rated for application at equipment.
2. At each building entry and exit point, protect wire communications trunk wiring with transient surge protection devices for minimal protection.
3. Transient surge protection is not necessary if communication trunk external to building is fiber optic.

D. Communications Links Overvoltage Protection:

1. Protect communications equipment such as modems, line drivers, and repeaters against overvoltage.
2. Include overvoltage protection for cables and conductors which serve as communications links for voltages up to 480 V AC RMS, 60 Hz. Instrument fuses, fusible resistors, or carbon surge arresters are acceptable for this application.

E. Sensor and Control Wiring Surge Protection:

1. Protect digital and analog inputs and outputs against surges and transients induced on control and sensor wiring.
2. Optical isolation, metal oxide varistors (MOVs), or silicon avalanche devices.

2.15 LIGHTING CONTROL

A. Description: DDC system shall interface with low voltage lighting control system specified in Division 26. DDC system subcontractor shall be responsible to coordinate with lighting control system vendor and electrical subcontractor to implement lighting control.

B. Graphic Interface: Include program such that each zone shows both occupied and status points on floor plan with zones highlighted.

C. Design Intent and Sequence of Operation: Refer to the Drawings.

PART 3 - EXECUTION

3.1 INSPECTION

A. Description: Verify installation conditions as satisfactory to receive the Work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

3.2 PREPARATION

A. Field Measurements: Field verify locations of new and existing work prior to commencing the Work of this section.

B. Protection: Protect surrounding areas and surfaces to preclude damage from the Work of this section.

3.3 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

A. General: Install, apply, erect, and perform the Work in accordance with Article “Quality Assurance” provisions, specifications, and manufacturer’s installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

3.4 WORK PRIOR TO INSTALLATION

A. General: Conduct pre-installation conference prior to DDC system subcontractor installing any materials required by this section. Conference shall occur after submittals have been satisfactorily reviewed by the A/E and approximately 14 days prior to proposed system installation date. Purpose of this conference is to review DDC system subcontractor installation methods, materials, schedule, safety, coordination with other trades, and related construction/design issues to allow for efficient and proper construction. The A/E and Owner will highlight various items of concern, typical problems encountered on similar projects, coordination issues, and related items.

B. Attendance: Pre-installation conference shall be attended by DDC system subcontractor doing the Work of this section, other mechanical and electrical trades as appropriate to proper coordination of work of this section, the Owner's representatives (at their option), and the A/E.

C. Coordination: DDC system subcontractor shall notify the A/E of system subcontractor readiness to hold pre-installation conference at least 14 days prior to proposed meeting time.

3.5 CONTROL SYSTEM, GENERAL

A. Description: Install devices and hardware required to ensure complete and operating system in accordance with sequences of operation.

B. Quality: Install components and wiring in neat and workmanlike manner, using trained mechanics, conforming to applicable codes. Perform installation under supervision of competent technicians regularly employed in installation of control systems.

C. Control Panels: In general, mount 4' - 6" above floor, panel top at 6' - 6" above floor maximum, with 3 feet minimum clear access space in front of panels. Indicate locations on the Shop Drawings.

3.6 DIRECT DIGITAL CONTROL SYSTEM

A. Control System Configuration:

1. Connect each major mechanical system to single trunk to permit intercommunication between DDC controllers and associated DDC controllers on particular system. This includes, but is not limited to, heating/chilled water systems, condenser water systems, and air handling systems.
2. Do not divide control of single mechanical system (such as an air handling unit, boiler, heat exchanger, chiller, or terminal equipment) between two or more DDC controllers when a larger single controller can meet point requirements. Single controller shall manage control functions for single mechanical system. Managing more than one mechanical system with single DDC controller is acceptable. If a single mechanical system cannot be controlled by a single controller, multiple controllers are acceptable.

B. Control Panels:

1. Locate and install DDC controllers in control panels for accessibility.

2. Include main power switch for each highest level LAN DDC controller within control panel.
3. Multiplexing of points not acceptable.

C. Software:

1. General: Install software as specified and required for operational DDC system, including database, operational parameters, system, command, and application programs.
2. User Access: Include multiple categories of access using passwords or other interlocks. Categories allow access to certain DDC system panels and to certain function levels.
3. Function Access: Include levels of access limiting functions allowable within each building group as follows as a minimum requirement:

    a. Level 1: Access to features of system.
    b. Level 2: Access to features of system except changing passwords and software algorithms.
    c. Level 3: Access to only those features associated with normal operation of system. No software changes possible.
    d. Level 4: Access to features on look-only basis.

3.7 INSTRUMENTATION AND CONTROLS

A. Installation, General:

1. Install devices to be easily accessible.
2. Install to protect instruments, switches, transmitters, and other devices from vibration and high temperatures.
3. Panel mount devices unless devices are installed directly on duct or piping.
4. In no case shall sensors designed for one application be installed for another application.

B. Relays and Contactors: Install interposing relays and contactors required to accomplish sequences of operation.

C. Thermostat and Temperature Sensor Locations: General locations indicated on the Drawings. Indicate actual locations on the Shop Drawings. Relocate if thermostat and temperature sensor performance is unsatisfactory at no additional cost to the Owner.

D. Room Thermostats and Temperature Sensors:

1. Install on interior walls to sense average room temperature conditions.
2. Avoid locations which may be covered by office furniture.
3. Do not mount on exterior walls when other locations are available. If located on exterior walls, install with insulated base.
4. Locate devices at same elevation.
5. Comply with requirements of Americans with Disabilities Act (ADA) as applicable. Install devices with maximum top elevation above finished floor in accordance with the following:

    a. ADA Applications, Forward Reach Access Only (No Obstructions): Top elevation 48 inch above finished floor.

b. ADA Applications, Side Reach Access (Parallel Approach Space Available): Top elevation 48 inch above finished floor.
c. Non-ADA Applications: Top elevation 60 inch above finished floor unless indicated otherwise in the Contract Documents.

E. Duct Thermostats and Temperature Sensors:

1. Install in ductwork with self-tapping sheet metal screws. Install metal rods and brackets to support averaging element. Element may be supported with existing supports where available.
2. Install in ductwork in general locations as indicated on the Drawings. Select specific location within duct to accurately sense appropriate air temperatures. Do not locate in dead air spaces or positions obstructed by ducts or equipment.
3. Install gaskets between sensor housing and duct wall. Seal duct and insulation penetrations.
4. Install duct averaging sensor between 2 rigid supports in serpentine position to sense average conditions. Thermally isolate temperature sensing elements from supports.
5. Install continuous averaging type for ductwork applications, 2 foot length for each 4 square feet of ductwork cross-sectional area with 5 foot minimum length.
6. Install single point type, one foot length minimum for ducts 3 foot square and less. Spot sensor if cross-sectional area is less than 18 square inch.

F. Outside Air Thermostats and Temperature Sensors:

1. Install outside on north side of building away from exhaust hoods, air intakes, and other areas that may affect temperature readings.
2. Install sunshields to protect thermostat from direct sunlight.

G. Low Temperature Protection Switches (Freezestat):

1. For each 40 square feet of coil-face area, install temperature switches to sense temperature at locations indicated on the Drawings. Install element in serpentine pattern.
2. Hard wire freezestat through transformer that serves outside air damper. Relying on controls logic to close outside air damper upon event not acceptable.

H. Pipe Temperature Sensors:

1. Install so that probe can be removed for field calibration and testing.
2. Establish location of thermowells for sensors measuring temperatures in liquid applications or pressure vessels.
3. Locate wells to sense continuous flow conditions.
4. Do not install wells using extension couplings.
5. Where piping diameters are smaller than length of wells, locate wells in piping at elbows to effect proper flow across entire area of well.
6. Wells not to restrict flow area to less than 70 percent of pipe area.
7. Apply thermal transmission material within well and install sealing nuts to contain thermal transmission material.
8. Coordinate well placement, size, and configuration with work of Section 232113.

I. Pressure Sensors and Switches:

1. Install in such manner that probe can be easily removed for field calibration and testing.

2. Establish location of thermowells for sensors measuring temperatures in liquid applications or pressure vessels.
3. Locate wells to sense continuous flow conditions.
4. Where piping diameters are smaller than length of wells, locate wells in piping at elbows to effect proper flow across entire area of well.
5. Wells not to restrict flow area to less than 70 percent of pipe area.
6. Apply thermal transmission material within well and install sealing nuts to contain thermal transmission material.
7. Coordinate well placement, size, and configuration with work of Sections 232113 and 232113.
8. Install pressure sensing tips in locations to sense appropriate pressure conditions. Install multiple pressure sensors as indicated on the Drawings or as required by the sequences of operation.
9. Install duct static pressure tip approximately 2/3 distance from supply fan to end of duct with greatest pressure drop.
10. For pump proof differential pressure switches, install low pressure sensor at pump suction and high pressure sensor at pump discharge.
11. For steam pressure sensing, install pig tail, snubbers, and isolation valves on steam pressure sensing applications.
12. For pumps controlled by variable frequency drives, install pressure sensors in piping mains as indicated on the Drawings.

J. Motorized Dampers and Actuators:

1. Install minimum of 1 actuator for each damper.
2. Arrange multi-section dampers so that each damper section operates individually with 1 actuator for each section.
3. For dampers installed in ducts, do not install actuators in air stream.
4. Install actuator on control shaft with positive locking mechanism.

K. Control Valves and Actuators:

1. Follow manufacturer’s recommendations for mounting, wiring, and applying control valve assembly.
2. Install three-way globe valves as mixing valves in return pipe from coil.
3. Install actuator on control shaft with positive looking mechanism.

L. Variable Frequency Drives: Install such that conduit length from drive to motor does not exceed manufacturer’s installation instructions.

M. Duct Smoke Detectors: Coordinate installation of duct smoke detectors with Section 233100. Install in return air ducts in accordance with NFPA 90A, except as otherwise indicated on the Drawings. Provide wiring to fan motor starters. Coordinate fire alarm system signal wiring with Division 28.

N. Fire Alarm Shutdown: Include wiring and relays to stop supply, exhaust, return, and relief air fans only upon receipt of signal from fire alarm control panel. Set of contacts will be available in fire alarm control panel under Division 28 work for this purpose. Shutdown system shall automatically reset when fire alarm system is reset.

O. Global Freeze Protection Override: At central operator workstation, include identifiable manually activated point to allow for global freeze protection override of heating and ventilating

systems. When outside air temperature drops below 29 F (user adjustable), heating water circulation pumps shall start and night set back temperature switches from normal set point to global set point of 65 F (user adjustable). Freeze protection program shall not directly start equipment but changes night setback temperature point and existing night set back controls to cycle equipment on and off. Identify current condition of this feature and display adjustable set points on central operator workstation. Include description next to each adjustable point that reads: "TOGGLE THIS FEATURE "ON" TO OPTIMIZE BUILDING FREEZE PROTECTION. PLACE IN "AUTO" FOR NORMAL OPERATION."

P. Global Air Handling System Emergency Shutdown: At central operator workstation, include identifiable manually activated point for global shutdown of building air handling equipment including exhaust fans. When single global point is manually set in "OFF" position, air handling equipment and exhaust fans shall shutdown. This mode of operation shall continue, regardless of time of day, until point is manually reset to "AUTO" position. Include place to toggle between "OFF" and "AUTO" positions on central operator workstation. Include description next to adjustable point for user direction that reads: "TOGGLE THIS FEATURE "OFF" TO SHUTDOWN AIR HANDLING EQUIPMENT INCLUDING EXHAUST FANS. PLACE IN "AUTO" FOR NORMAL OPERATION."

Q. Global Damper Override: At central operator workstation, include identifiable manually activated point for global 100 percent outside air damper opening of building air handling equipment. This same point shall allow for global 0 percent outside air damper opening of building air handling equipment. When this single global point is manually set to "100 %" position at central operator workstation, air handling units shall place outside air dampers in 100 percent position. Similarly, when this single global point is manually set to "0 %" position at central operator workstation, air handling units shall place outside air dampers in the 0 percent position. This mode of operation shall continue, regardless of time of day, until point is manually reset to "AUTO" position. Include place to toggle between "100 %", "0 %", and "AUTO" positions on central operator workstation. Include description next to adjustable point for user direction that reads: "TOGGLE THIS FEATURE "100 %" FOR 100 % OPEN OUTSIDE AIR DAMPERS AT AIR HANDLING EQUIPMENT. TOGGLE THIS FEATURE "0 %" FOR 0 % OPEN OUTSIDE AIR DAMPERS AT AIR HANDLING EQUIPMENT. PLACE IN "AUTO" FOR NORMAL OPERATION."

R. Nameplates, Tags, and Laminated Shop Drawings:

1. Nameplates and Tags:

   a. Install at field mounted equipment and devices, engraved with legend, unique identifier, or equipment name to correspond to designations on record control drawings.
   b. Install on outside face of control panel doors.
   c. Permanently attach with rivets or screws.

2. Laminated Shop Drawings:

   a. Prior to date of Substantial Completion, provide Shop Drawings, including control wiring diagrams, ladder diagrams, logic diagrams, flow charts, and similar items, in clear laminated plastic, 11 by 17 inch size.
   b. Prepare full set of Shop Drawings and deliver to the Owner at central operator workstation.
   c. Install drawings specific to a control panel within that control panel.

d. At end of warranty period, provide replacement laminated Shop Drawings to reflect setpoints that the Owner has established.

3.8 CONTROL WIRING

A. General:

1. Comply with NEC requirements.
2. Label each line voltage power supply with identification of feeder panel and breaker.

B. Conduit and Wireways:

1. Conduit and couplings in exposed interior locations, including mechanical equipment rooms, below raised floors, and in HVAC plenums shall be electrical metallic tubing (EMT), hot-dipped galvanized, or electro-galvanized steel tubing with steel compression fittings. Minimum 3/4 inch conduit size.
2. Install offsets and fittings necessary to accomplish installation of control system.
3. Seal conduit with glass fiber where conduits leave heated area and enter unheated area.
4. Alter conduit routing to avoid structural obstructions and minimize cross-overs.
5. Allow minimum 6 inch of clearance at flues, heating water pipes, and heat sources.

C. Wiring above Inaccessible Ceilings and above Ceilings in Fire Rated Exit Corridors:

1. Install in conduit, wireway, or limited energy cable tray provided under Division 26, properly supported.
2. Wiring in ceiling spaces above suspended acoustical tile ceilings may be installed without conduit.
3. Conduit, wireway, or cable tray shall continue to within 12 inch of sensors and controlled devices.

D. Wiring Above Accessible Ceilings:

1. Regardless as to whether ceiling space is used as return air plenum, use plenum cable. This includes exposed wiring, wiring in cable trays, and wiring between conduit terminations and sensors and controlled devices.
2. Install plenum cable at least 12 inch above ceiling tiles. Do not lay on top of ceiling tiles. Route plenum cable in a straight line supported by cable rings on 4 foot minimum centers and attached to building walls or supported by mechanically fastening to pipes or ducts.

E. Wiring within Control Panels: Arrange neatly in grouped horizontal and vertical directions, secured or under removable covers. Rewire non-conforming work as directed by the A/E. Protect exposed wiring from abuse and damage.

F. Wire Terminations: Make bare to screw terminals specifically designed for bare stranded wire connections, or with self-insulated spade lugs where connected to screw type terminals not specifically designed for bare stranded wire connection.

G. Splicing:

1. Minimize and perform only in accessible outlet, junction, or cabinet boxes that are included on the Drawings.

2. When splicing is necessary, match insulation colors and mechanically secured conductors to each other so that no stress is applied to the splice.

H. Wire Runs: Parallel or perpendicular to walls, pipes and sides of openings. Use right angle turns. Do not block passage ways for access and servicing. Do not install control wiring in power circuit raceways. Do not use motor starters and disconnect switches as junction boxes. Install additional junction boxes.

I. Fill: No conduit shall be filled such that maximum bundled cross sectional dimension exceeds 65 percent of conduit inside diameter. No raceway filled to more than 40 percent, except that maximum fill for surface raceway shall be 20 percent.

J. Wire Length: Wire run or circuit no longer than 80 percent of maximum allowable length or power consumption for wire size and application. Output circuit not to exceed 80 percent of maximum load capacity specified by manufacturer.

K. Identification: Conduits entering and leaving terminal cabinets and junction boxes identified in logical and consecutive manner. Use same number only once. Identify conductors with typed or machine lettered labels, Brady or approved. Tag numbers agree with wire numbers assigned on wiring diagrams and installation drawings. Number wires at each connection, termination, and junction box.

L. Grounding: Ground controllers and cabinets to a good earth ground. Ground controller to ground in accordance with requirements in Division 26. Grounding of green AC ground wire at electrical circuit breaker panel alone, not acceptable. Run metal conduit from controller panels to adequate building grounds. Ground sensor drain wire shields at controller end.

M. Electric Power for Controls:

1. Coordinate electrical power source required for work of this section with Division 26.
2. Where not shown on electrical drawings, provide power wiring from electrical panel circuit breakers to controls system panels and devices requiring line voltage power. Provide limited energy transformers. Comply with NEC. Provide a disconnect on primary side of transformer and a resettable, fused cut-out on the secondary side of transformer.
3. Do not connect control wiring to receptacle or lighting circuits.
4. Transformers and line voltage controllers used to control a specific piece of equipment may be fed from power leads to that specific piece of equipment.
5. Where emergency power is included in the work or exists in building, extend electrical power source for control from that emergency power system.

N. Surge Protection for DDC System: Install surge protection no more than 3 feet from where communication cable enters building.

O. Devices Specified in Other Divisions and for Existing Installations: Provide connections between control system components and sensor and control and alarm devices which require connections to controls system. Coordinate specific requirements with device or unit manufacturer.

P. Low Voltage Wiring: Comply with requirements in Section 230513. Unless otherwise indicated on the Drawings, other Division 22 and 23 sections, or in Division 26, provide low voltage wiring for work of Divisions 22 and 23, including but not limited to:

1. Duct smoke detectors to associated fan motor starters.
2. Chiller components field wiring.
3. Heat Pump chiller controller and chilled water pump interlock field wiring as required by chiller manufacturer.
4. Temperature and flow control wiring.
5. Domestic water heater field wiring.
6. Chemical water treatment field wiring.
7. Gas fired equipment field wiring.
8. Air handling and heat recovery unit control components field wiring.
9. Solenoid valves.
10. Hydronic flow meter system.
11. Pressure sensor for hydronic systems

Q. Line Voltage Wiring: Comply with requirements in Section 230513. Unless otherwise indicated on the Drawings or in Division 26, provide line voltage wiring from electrical panel circuit breakers to control panels and devices including but not limited to:

1. Control panels.
2. Chiller components field wiring.
3. Domestic water heater field wiring.
4. Automatic butterfly valves.
5. Chemical water treatment field wiring.
6. Gas fired boiler remote shutdown switch.
7. Smoke damper indication.
8. Air handling and heat recovery unit control components field wiring.
9. Hydronic flow meter system.
10. Pressure sensor for hydronic systems

3.9 SEQUENCES OF OPERATION

A. Description: Refer to the Drawings for sequences of operation.

3.10 CLEAN-UP

A. Description:

1. Promptly remove waste material and rubbish as it accumulates.
2. At completion of the Work, clean dirt and construction debris, such as paint, plaster, glue, cement, mastic, tar, paper, tape, and dirt from the installation.
3. In finished areas to be occupied, keep equipment covered during construction. Where this is not practical, clean and refinish item to new condition.

3.11 FIELD TESTING AND VERIFICATION

A. Field Tests: Calibrate field equipment and devices and verify equipment and system operation before placing automatic temperature control system on-line.

B. Include the Following Tests:

1. Preliminary: Observe HVAC system in its shutdown condition. Check motorized dampers and control valves for proper normal positions.
2. Check each input device for proper calibration and operation. For each sensor, record readings at sensor and DDC system controller using traceable test equipment. Document each reading for test report.
3. Check operation of each output to verify correct operation. Command digital outputs on and off. Command analog outputs to minimum range, such as 4 mA, and maximum range, such as 20 mA. Measure and record commanded and actual output values. Document each command and result for test report.
4. With DDC system controller, apply control signal to each actuator and verify that actuator operates properly from its normal position to full range of stroke position. Record actual spring ranges and normal positions for modulating control valves and dampers. Include documentation in test report.
5. Demonstrate that programming is not lost after power failure and DDC system controllers automatically resume proper control after power failure.
6. Demonstrate that surge protection has been installed on incoming power to DDC system controllers and on communications lines.

C. Software Operation Tests: Test compliance of application software for:

1. Demonstrate ability to upload and download control programs.
2. Demonstrate ability to edit control program off line.
3. Cause alarm conditions for each alarm and ensure that central operator workstation receives alarms.
4. Demonstrate ability of software to receive and save trend and status reports.

D. Performance Verification Tests:

1. Conduct performance verification tests to demonstrate that DDC system maintains setpoints, control loops are tuned, and controllers are programmed for correct sequences of operation.
2. Conduct performance verification test during one week of continuous control systems operation before final acceptance of work.
3. Include the following:

    a. Execution of Sequences of Operation:

        1) Demonstrate that mechanical system operates properly through complete sequences of operation (for example, seasonal, occupied/unoccupied, and warm-up cycles).
        2) Demonstrate that hardware interlocks and safeties operate properly.
        3) Graph trends to show sequences of operation are executed in correct order.
        4) Demonstrate proper system response for abnormal conditions by simulating these conditions.
        5) Demonstrate that system performs sequences of operation after power failure.
        6) Opposite Season Test: Repeat performance verification test during opposite season to first performance verification test. Test procedures of performance verification test shall be used for opposite season test.

    b. DDC System Loop Stability and Accuracy: Graph trends of control loops to demonstrate control loop is stable and that setpoint is maintained. Control loop

response shall respond to setpoint changes and stabilize in 1 minute. Control loop trend data shall be instantaneous and time between data points not greater than 1 minute.

c. Maximum allowable deviation of controlled values from their setpoints shall be as follows:

1) Air Handling Unit Supply Air Temperature: Setpoint plus or minus 0.5 F.
2) Chilled Water Supply Temperature: Setpoint plus or minus 1.0 F.
3) Heating Water Supply Temperature: Setpoint plus or minus 1.5 F.
4) Room Temperature: Heating setpoint minus 0.5 F; cooling setpoint plus 0.5 F.
5) Duct Static Pressure (For Fan Speed Control): Setpoint plus or minus 10 percent.
6) Hydronic Pressure (For Pump Speed Control): Setpoint plus or minus 10 percent.

d. Test each point reporting to DDC system controllers and remote controllers for specified functions. Sign off test results by DDC system subcontractor and the A/E.

3.12 HVAC SYSTEMS TRAINING

A. Comply with requirements in Section 230810.

3.13 COMMISSIONING

A. Equipment and systems referenced in this section shall be commissioned per Section 230800. The Contractor has specific responsibilities for scheduling, coordination, test development, testing and documentation.

END OF SECTION 230900

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Description: The Work includes variable frequency drives (VFD) for Divisions 22 and 23 equipment. VFDs shall be furnished and installed by controls system subcontractor specified in Section 230900.

B. Contract Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to the Work in this section.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.

B. Codes and Standards:

1. IEEE 519, IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.
2. NFPA 70, National Electrical Code.
3. UL 508, Industrial Control Equipment.

C. Installer Qualifications: Installing contractor shall have successfully installed VFDs in at least 3 facilities. Installations shall be similar in configuration to this project.

1.3 SUBMITTALS

A. Comply with requirements in Division 01 and Section 230500.

B. Product Data: Submit manufacturer's technical product data and maintenance data and control wiring diagram indicating factory and field installed wiring for each VFD and appurtenance as follows. Indicate accessories where required for complete system and installation instructions. Identify manufacturer's recommended maximum distance between VFD and motor controlled by VFD.

1. Manufacturer.
2. Components and requirements.
3. Operating conditions.
4. Blank copy of start-up and test report form.

C. Shop Drawings: Submit control wiring diagram indicating factory and field installed wiring.

D. Motor Compatibility: Coordinate with motor manufacturer to guarantee that motor will operate properly with VFD without objectionable motor noise, heat, or loss of efficiency.

E. Test Reports:

1. Factory start-up and test reports.
2. Field start-up and test reports.
3. Submit completed copy of reports and include copy in the Operations and Maintenance Manual.

1.4 WARRANTY

A. Warrant VFD components for 3 years after final acceptance date. Warranty shall cover materials, labor, and travel time. Make available replacement within 48 hours of initial notification.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: ABB ACH550, or Danfoss VLT HVAC. No substitutions. Multiple manufacturers not acceptable.

B. Manufacturer shall maintain a service center or service representative within 50 miles of the project site. This center shall be capable of the following services:

1. Factory coordinated start-up service.
2. Emergency service calls, including replacement parts, within 24 hours.
3. Service contracts.
4. Training of customer personnel in operation and basic troubleshooting.
5. Stock of frequently replaceable parts at local warehouse.

2.2 COMPONENTS AND REQUIREMENTS

A. Description:

1. General: Variable torque type.
2. Performance:

a. Conversion of 3 phase, 60 Hertz AC input power to adjustable voltage and frequency, 3 phase AC power for stepless motor control from 10 percent to 110 percent of base speed. Obtain input power voltage from Division 26.
b. Capable of starting, stopping, and driving an AC variable output from 0 to 60 Hz while maintaining constant Volts/Hertz ratio. Adjustable Volts/Hertz ratio via keypad. Capable of delivering 110 percent starting torque.
c. Sized as required by motors as indicated on the Drawings.

B. Construction:

1. UL listed and labeled assembly including specified options.
2. Major components:

a. Diode front end to convert AC to DC to create fixed DC bus voltage.

b. Phase-to-phase and phase-to-ground metal oxide varistor (MOV) protection.
c. Smoothing reactor for DC bus.
d. DC bus capacitors.
e. Insulated Gate Bipolar Transistors (IGBT) to create Pulse Width Modulated (PWM) waveforms to control motor speed.
f. Separate terminal blocks for control and power wiring.

C. Enclosure: UL listed and labeled. NEMA rated for installation location as follows: NEMA 1 for clean indoor locations; NEMA 3R for outdoors; and NEMA 12 for dirty indoor locations and within air handling unit plenums. Surface mounted cabinet with hinged front door, top or bottom conduit entry, and key lockable. Manufacturer's standard paint finish.

D. Overcurrent Protection: Input line overcurrent protective device, thermal magnetic type, externally operated and interlocked with enclosure door. Include UL Listing label indicating assembly is short circuit interrupting rated (SCCR) of 100,000 Amps.

E. Components and Requirements:

1. Main electric disconnect lockable in "ON" and "OFF" positions. Include common keyed padlocks.
2. Door interlock to prevent door from being opened when operating handle is in "ON" position. Interlock defeatable through simple, but not obvious, means.
3. Internal control power circuit with transformer and protective fuses.
4. Meet or exceed the current ratings listed in NFPA 70 for motors being controlled.
5. UL listed and labeled for electronic overload protection of motor.
6. Five percent line reactors in form of AC reactor, DC reactor, or a combination of the two.
7. Limit motor noise as result of VFD to 3 dB over line operation, measured at 3 feet from motor center line. If still deemed too noisy by the Owner, make adjustments to VFD components.
8. Relay Contacts: One SPDT "fault" and 2 SPST programmable multi-function minimum. Rated for 1 Amp 240 V AC and 1 Amp 30 V DC minimum. Open collector outputs not acceptable.
9. Adjustable acceleration and deceleration, commonly or separately, from 10 to 180 seconds with torque override acceleration protection and regeneration protection during deceleration.
10. Automatic adjustment of Volts-to-Hertz ratio to motor in proportion to load without changing speed.
11. Separately adjustable minimum/maximum frequency limits.
12. Low frequency/low voltage start with linear adjustable ramp up to pre-selected speed.
13. Status Lights: Door-mounted LCD indicators to indicate the following conditions:

    a. Power on.
    b. Run.

14. Thru-the-door operator interface with keypad and alphanumeric display for parameter setting and monitoring of:

    a. Output frequency.
    b. RPM.
    c. Output voltage.
    d. Output current.
    e. Running time by real time clock.

f. Faults for overvoltage, line fault, overcurrent, and external fault (including memory of last 3 received faults).
g. Display to read in English words without use of codes.
h. DC bus voltage.
i. Calculated motor torque.
j. Calculated motor power (kW).
k. Parameters set via keypad without removing drive cover.

15. Auxiliary relay contact for remote fault indication to DDC system specified in Section 230900.
16. Manual speed setting on operator interface.
17. Hand-off-auto switch on door. In “HAND” position, speed is controlled by door mounted speed potentiometer or keypad with “UP/DOWN” arrow keys. In “OFF” position, VFD cannot be started. In “AUTO” position, speed is controlled by remote signal and VFD can receive remote start command. Stop command in “AUTO” position can be either remote, integral, or from door mounted “HOA” switch.
18. Overtemperature shutdown.
19. Input power dip ride through.
20. Output short circuit and ground fault protection.
21. Start into spinning motor protection. Motor may be turning in either direction.
22. Overvoltage and undervoltage protection.
23. Current limit and torque limit capability.
24. Automatic restart after power interruption and after power decay (brownout) within 5 seconds. Automatic restart selectable via software programming.
25. Signal follower for 0 to 10 V DC or 4 to 20 mA inputs, direct and reverse acting.
26. Critical frequency range lockout, minimum of 2 critical frequency ranges.
27. Serial Communication (RS 485). Coordinate requirements with DDC system specified in Section 230900.
28. Output circuitry designed for constant duty with VFD operating at full rated load to prevent peak output voltage from reaching 1000 V to ground at motor.
29. Software programming for monitoring and commissioning by use of laptop personal computer.
30. Include output dry contacts for VFD failure, “ON/OFF” input which responds to remote dry contact closure, and speed control input which responds to remote 0 to 10 V DC and 4 to 20 mA signals.
31. RS-232 or USB communication port.
32. Running time clock.
33. Option slots for optional I/O cards.

F. DDC System Interface:

1. Include hardware, software, and connection cables to digitally communicate and exchange information with DDC system specified in Section 230900.
2. Include monitoring and control of motor speed, electric load in kW, Volts, Amps, Hertz, percent of maximum motor speed, VFD fault description, and “HOA” modes, and network point address.
3. VFD able to modify settings including acceleration and deceleration times and skip frequency ranges via DDC system central operator workstation.

G. Fire Alarm System Interface:

1. Include dry contact override input to stop motor under any operating condition.

2. Include dry contact override input to allow motor to operate at a speed predetermined by VFD programming.
3. Include summary alarm dry contact for connection to fire alarm system indicating that VFD is not operable.

2.3 OPERATING CONDITIONS

A. Displacement Power Factor: Minimum 0.95 at any speed on load.

B. Efficiency: Minimum 95 percent at rated load and frequency.

C. AC Line Frequency Variation: Plus 2 Hz.

D. AC Line Voltage Variation: Minus 10 percent to plus 10 percent.

E. Capacity: 100 percent continuous, 110 percent for 60 seconds (10 percent overload).

F. Input Power: Limited to 110 percent of motor load as derived in NFPA 70.

G. Total Harmonic Voltage Distortion: Less than 3 percent without isolation transformer.

H. Ambient Temperature: 32 F to 104 F.

I. Relative Humidity: 0 to 95 percent, non-condensing.

J. Elevation: Up to 3300 feet without derating output power capability.

PART 3 - EXECUTION

3.1 INSPECTION

A. General: Verify installation conditions as satisfactory to receive the Work of this section. Do not install until any unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

3.2 PREPARATION

A. Field Measurements: Field verify locations of new and existing work prior to commencing the Work of this section.

B. Protection: Protect surrounding areas and surfaces to preclude damage from the Work of this section.

3.3 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

A. General: Install, apply, erect, and perform the Work in accordance with Article “Quality Assurance” provisions, specifications, and manufacturer’s installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

B. Do not install VFDs until building environment can be maintained within conditions required by manufacturer.

C. Before and during installation, protect VFD from site contaminants.

D. Coordinate required electrical and control installation work with Division 26 and Section 230900.

E. Install VFDs on rigid formed steel channels as specified in Section 230510 or on building structure so that power wiring connecting VFD to motor is within limits of manufacturer’s installation requirements. Install multiple VFDs so that cooling discharge air does not affect adjacent VFD cooling source. Direct installation on concrete and concrete masonry unit walls not acceptable.

3.4 START-UP SERVICES

A. Manufacturer’s authorized representative shall perform the following services:

1. Verify installation connections and controls. Test continuity of each circuit.
2. Adjust safety controls.
3. Adjust acceleration and deceleration ramps and Volts-to-Hertz characteristic.
4. Demonstrate satisfactory operation including line reactor during test run.
5. Program VFD to automatically reapply power and drive motor to control setpoint upon resumption of power following power failure.
6. Program VFD to attempt up to 3 automatic restarts within one hour after shutdown due to input power failure.
7. Perform field assistance and additional technical support and devices to solve problems evidenced on site related to drive operation.
8. Include field assistance and additional technical support and devices to solve problems evidenced on site related to VFD operation.

3.5 WIRING

A. Power Wiring: Comply with requirements in Division 26. In addition, install line and load circuits in separate conduits. Install each VFD load circuit in separate conduit. No other circuits, including local service disconnect switch interlock wiring, shall share that conduit. If VFD cable is used for the motor circuit, provide grounding at each end.

B. Control Wiring: Install with separate conduit. Comply with requirements in Section 230900.

3.6 HVAC SYSTEMS TRAINING

A. Comply with requirements in Section 230810.

B. Representative shall conduct training session to demonstrate that equipment operates as indicated in the Contract Documents and in accordance with manufacturer's recommendations. Coordinate with controls subcontractor. Give minimum one week notice prior to demonstration. Furnish instruments and personnel required to conduct demonstration.

C. Starting time (during any normal operating shift) of training sessions will be determined by the Owner to minimize overtime required for his maintenance personnel.

D. Demonstrate proper performance of operating and safety controls, as well as stable performance over entire operating range to satisfaction of the Owner prior to Substantial Completion.

E. Include instruction session to identify locations of servicing points and required maintenance requirements to the Owner's personnel.

F. Include preliminary discussion and presentation of information from instruction manuals, with appropriate references to the Contract Documents, followed by tour explaining maintenance requirements, access methods, servicing and maintenance procedures, equipment cleaning procedures, control settings and available adjustments.

G. After 30 days of normal operation schedule meeting with the Owner's maintenance personnel responsible for VFD operation and supplier's software technician to outline software changes to meet specific system requirements. Job specific software changes agreed upon at this meeting shall be made at no extra cost to the Owner.

3.7 COMMISSIONING

A. Equipment and systems referenced in this section shall be commissioned per Section 230800. The Contractor has specific responsibilities for scheduling, coordination, test development, testing and documentation.

END OF SECTION 230915

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Description: The Work includes HVAC hydronic piping and associated appurtenances for heating water and chilled water systems.

B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to the Work in this section.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.

B. Codes and Standards:

1. ASME B16.1, Cast Iron Pipe Flanges and Flanged Fittings.
2. ASME B16.3, Malleable Iron Threaded Fittings: Classes 150 and 300.
3. ASME B16.5, Pipe Flanges and Flanged Fittings NPS 1/2 through 24 Inch Standard.
4. ASME B16.9, Factory-Made Wrought Steel Buttwelding Fittings.
5. ASME B16.11, Forged Fittings, Socket-Welding and Threaded.
6. ASME B16.18, Cast Copper Alloy Solder Joint Pressure Fittings.
7. ASME B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
8. ASME B16.39, Malleable Iron Threaded Pipe Unions Classes 150, 250, and 300.
9. ASME B31.1, Power Piping.
10. ASME B31.9, Building Services Piping.
11. ASME BPVC, Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications.
12. ASME BPVC, Boiler and Pressure Vessel Code, Section VIII, Division 1.
13. ASTM A 53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
14. ASTM A 105, Standard Specification for Carbon Steel Forgings for Pipe Applications.
15. ASTM A 106, Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
16. ASTM A 126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
17. ASTM A 181, Standard Specification for Carbon Steel Forgings, for General-Purpose Piping.
18. ASTM A 183, Standard Specification for Carbon Steel Track Bolts and Nuts.
19. ASTM A 197, Standard Specification for Cupola Malleable Iron.
20. ASTM A 536, Standard Specification for Ductile Iron Castings.
21. ASTM B 32, Standard Specification for Solder Material.
22. ASTM B 75, Standard Specification for Seamless Copper Tube.
23. ASTM B 88, Standard Specification for Seamless Copper Water Tube.
24. ASTM B 372, Standard Specification for Seamless Copper and Copper-Alloy Rectangular Waveguide Tube.

25. ASTM B 633, Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
26. ASTM B 813, Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube.
27. ASTM B 828, Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings.
28. ASTM D 380, Standard Test Methods for Rubber Hose.
29. ASTM E 84, Standard Test Method for Surface Burning Characteristics of Building Materials.
30. AWS A5.8, Specification for Brazing Filler Metal.
31. AWS D10.12, Guide for Welding Mild Steel Pipe.
32. CAN/ULC 102.2, Method of Test for Surface Burning Characteristics of Flooring, Floor Coverings, and Miscellaneous Materials and Assemblies.
33. DIN 4726, Warm Water Surface Heating Systems and Radiator Connecting Systems – Plastics Piping Systems and Multilayer Piping Systems.
34. NSF 14, Plastic Piping System Components and Related Materials.
35. NFPA 99, Standard for Health Care Facilities.
36. NFPA 13, Standard for the Installation of Sprinkler Systems.
37. NFS 61, Drinking Water Systems Components - Health Effects.
38. Plastics Pipe Institute (PPI), Technical Report TR—4. Recommended Hydrostatic Strengths and Design Stresses for Thermoplastic Piping and Fitting Compounds.

C. Installer Qualifications for Copper Press Fitting Couplings: Installers shall be certified by the pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.

D. Welding: Qualify processes and operators according to ASME BPVC.

1. Comply with provisions in ASME B31 Series, “Code for Pressure Piping.”
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

1.3 SUBMITTALS

A. Comply with requirements in Division 01 and Section 230500.

B. Product Data: Submit manufacturer’s technical product data and maintenance data for each type of piping, fittings, and associated appurtenances for the following.

1. Steel piping.
2. Copper tubing including solder and flux
3. Dielectric unions.
4. Pre-insulated, underground, direct buried hydronic piping.
5. Expansion tanks.
6. Air separators.
7. Flow control valve assemblies.
8. Pressure independent flow control valves.
9. Cold water fill assemblies.
10. Automatic air vents.
11. Manual air vents.
12. Sight flow indicators.

13. Piping specialties.
14. Blank copy of start-up and test report form.

C. Shop Drawings:

1. Comply with requirements in Section 230500 regarding 3D Shop Drawings.
2. Pre-Insulated, Underground, Direct Buried Hydronic Piping.

D. Welding certificates:

E. Installer Qualification Data for Copper Press Fitting Couplings.

F. List of names of installers trained by pre-insulated, underground, direct buried hydronic pipe system manufacturer in installation of system. Only those named on list will be allowed to install system. List shall not be more than 1 year old.

G. Test Reports:

1. Field test reports.
2. Site visit reports.
3. Submit completed copy of reports and include copy in the Operations and Maintenance Manual.

1.4 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION

A. Section 230548 - Vibration Isolation: Flexible connectors.

B. Section 230900 - Automatic Temperature Controls: Control and differential pressure valves, water pressure and differential pressure taps, valve manifolds, flow meters, flow switches, thermal wells, and similar components.

C. Section 232123 - Hydronic Pumps: Pump discharge flexible connectors.

D. Section 232500 - Water Treatment: Water treatment equipment and associated components.

E. Section 236420 –Air Cooled Chillers: Flow switches.

PART 2 - PRODUCTS

2.1 GENERAL

A. Furnish products of sizes, ratings, and characteristics indicated which comply with manufacturer’s standard materials, design, and construction in accordance with published product information. Furnish quantity of piping and appurtenances required for complete installation.

B. Pressure Ratings: Provide components with minimum pressure rating of 125 psig working pressure.

2.2 MANUFACTURERS

A. Steel Pipe: U. S. Steel, Sharon Tube, Vision Metals LLC, California Steel Industries, Maruichi American Corporation, National Pipe & Plastics Inc., TMK IPSCO, Wheatland Tube.

B. Copper Tubing: Cerroflow, Mueller Industries, Wolverine Tube, Inc., Cambridge-LeeIndustries LLC.

C. Steel Pipe Fittings: Anvil International, Mill Iron Works Inc., HackneyLandish, Inc., Ward Manufacturing LLC, Phoenix Forging Company, Allied Tibe & Conduit, Tube Forgings of America, Vogt Forged Steel Pipe Fittings, Bonney Forge®, Stockham Valves and Fittings.

D. Copper Tube Fittings: NIBCO®, Mueller Industries, Elkhart Brass Mfg.

E. Gaskets: John Crane, Garlock, United Seal & Rubber Co., Anchor Seals inc., Flexitallic.

F. Shaped Nipples: Allied Tube & Conduit, Bonney Forge®.

G. Grooved Joint Products: Victaulic Co. No substitutions.

H. Origin: Items shall be manufactured in the United States.

2.3 STEEL PIPING

A. Pipe: Black steel, Schedule 40, Standard weight for 10 inch and smaller and 0.375 inch wall for 12 inch and larger, ASTM A 53, Grade A or B, or ASTM A 106, Grade A, B, or C.

B. Fittings:

1. 2-1/2 Inch and Smaller: 150 pound WSP, black malleable iron, screwed, ASME B16.3 and ASTM A 197; 3000 pound forged steel socket weld, ASME B16.11 and ASTM A 105. Threadolet type fittings acceptable for 2 inch and smaller.
2. 3 Inch and Larger: Standard weight, seamless steel, butt welding, ASME B16.9, Grade WPB. Weldolet type fittings acceptable.

C. Grooved Joint Couplings and Fittings:

1. Suitable for carbon steel piping. Size range 3/4 to 24 inch.
2. Compatible fittings, butterfly valves, and flange adapters. Factory grooved, ready for installation.
3. Couplings ductile iron, ASTM A 536. Saddle type tee fittings not acceptable.
4. Gaskets Grade “E” EPDM, temperature range minus 30 F to plus 230 F.
5. Bolts and nuts heat treated carbon steel, zinc electroplated to ASTM B 633, track-head conforming to physical properties of ASTM A 183, minimum tensile 110,000 PSI.
6. Lubricant compatible with gasket material per manufacturer’s recommendations.**]**

D. Unions, 2-1/2 Inch and Smaller: 150 pound WSP, black malleable iron, screwed, ASME 16.39, brass seat.

E. Pipe Nipples: Same piping material as connecting piping; Schedule 80 for 1-1/2 inch unthreaded length with pipe sizes less than 1-1/4 inch. Close nipples not acceptable.

F. Flanges:

1. 2-1/2 Inch and Smaller: 125 pound WSP, cast iron screwed, ASME B16.1 and ASTM A 126, Class B; 150 pound forged steel weld neck or slip-on, ASME B16.5 and ASTM A 181, Grade I; 150 pound forged steel socket weld, ASME B16.5 and ASTM A 181, Grade I.
2. 3 Inch and Larger: 150 pound forged steel weld neck or slip on, ASME B16.5 and ASTM A 181, Grade I. Flanges facing flat faced cast iron flanges with flat face finish. Grooved joint couplings may be used in lieu of flanges.
3. Gaskets: 1/16 inch thick compressed non-asbestos material selected for applicable temperature and pressure of systems installed. Full face gaskets for flat faced flanges.
4. Joint Compound: Teflon tape.

2.4 COPPER TUBING

A. Tubing, Above Ground: Type L copper water tube, hard-drawn, ASTM B 88.

B. Tubing, Underground: Type K copper water tube, soft-drawn, ASTM B 88.

C. Fittings: Wrought copper fittings and screwed adapters for soldered and brazed joints, ASME B16.22; cast bronze fittings and screwed adapters for soldered and brazed joints, ASME B16.18.

D. Copper Press Fitting Couplings and Fittings:

1. Suitable for Types K and L hard drawn copper tubing for sizes 1/2 through 2-1/2 inch and soft drawn copper tubing for sizes 1/2 through 1-1/4 inch. Press-to-connect joint made with pressing tool and jaw sets recommended by fitting manufacturer. NIBCO® Press System™, Viega ProPress System, or Elkhart XPress. No substitutions.
2. Approved by NSF International, IAPMO, UL and compliant with UPC, NFPA 13, and NFPA 99.
3. Wrought copper fittings per ASTM B 75 conforming to ASME B16.18 or ASME B16.22. Rated to maximum 200 psig non-shock working pressure for temperature range between minus 20 F to 250 F.**]**

E. Unions: Wrought copper solder joint unions, ASME B16.22; cast bronze solder joint fittings, ASME B16.18.

F. Flanges and Flanged Fittings: Cast bronze, 125 pound Class, ASME Standards.

G. Gaskets: 1/16 inch thick compressed non-asbestos material selected for applicable temperature and pressure of systems installed. Full face gaskets for flat faced flanges.

H. Joint Compound: Teflon tape.

I. Solder Material: 95 percent tin, 5 percent antimony solder or 96 percent tin 4 percent silver conforming to ASTM B 372 and NFS 61. Lead free (not more than 0.25 percent lead). Flux water soluble conforming to ASTM B 813. J.W. Harris “Bridgit”, RectorSeal, Oatey SCS, Superior Flux & Mfg. Co., Worthington Industries, BerzOmatic, or approved.

J. Brazing Material: Copper-phosphorus alloys, BcuP Series, conforming to AWS A5.8. Lead free (not more than 0.25 percent lead) conforming to ASTM B 372 and NSF 61. Flux water soluble conforming to ASTM B 813. RectorSeal, Oatey SCS, Superior Flux & Mfg. Co., or approved.

2.5 DIELECTRIC UNIONS

A. Union Style: Grooved, threaded, or plain end, ASTM F 1545. Capital Manufacturing Company Series CS; Epco Dielectric Unions, PPP Clearflow® Dielectric Waterway, or Victaulic Clearflow Dielectric Waterway.

B. Flange for 2-1/2 Inch and Larger: ASTM F 1545, insulating flange union per companion, 1/2 flange union with bolt insulators, dielectric gasket, bolts and nuts. Capital Manufacturing Company Series F, Epco, or Victaulic Clearflow Dielectric Waterway.

C. Ratings: Select temperature and pressure applicable for systems in which they are installed.

2.6 ADDITIONAL REQUIREMENTS AND EXCEPTIONS

A. Unless noted otherwise, copper tubing required for sizes 2-1/2 inch and smaller and black steel piping for sizes 3 inch and larger with welded joints or grooved joint couplings and fittings. Copper tubing acceptable for sizes 3 inch and larger with brazed joints or grooved joint couplings and fittings.

B. Heating Water Piping: Grooved joint couplings and fittings and copper tubing required in mechanical and boiler rooms

C. Chilled Water Piping: Grooved joint couplings and fittings and copper tubing required in mechanical and boiler rooms

2.7 EXPANSION TANKS

A. Description: Pre-pressurized replaceable bladder type for hydronic system pressure reference.

B. Construction: Welded steel, ASME BPVC tested and stamped, supplied with National Board Form U-1, rated for working pressure of 125 psig, flexible bladder sealed into tank, steel legs or integral ring mount base for vertical units or saddles for horizontal units.

C. Bladder: Sealed into tank, butyl for systems containing water.

D. Accessories: Pressure gage and air-charging fitting, tank drain. Pre-charge to pressure indicated on the Drawings.

E. Manufacturers: AMTROL, Armstrong Fluid Technology, Bell & Gossett, or approved.

2.8 AIR SEPARATORS

A. Coalescing Type Combination Air Eliminator/Dirt Separator:

1. Description: Turbulence suppressive type microbubble combination air eliminator/dirt separator, 125 psig maximum working pressure, 250 F maximum working temperature. ASME BPVC tested and stamped.
2. 2 Inch and Larger: Steel shell with centered inlet and outlet, brass vent head, brass or bronze skim valve, copper or stainless steel coalescing medium, 150 psig flanged piping connections, full port NPT blowdown valve and Siprotherm Spirotop Air Release Valve Model VTP. Vessel extended below pipe connections for dirt separation. Spirotherm Spirovent High Velocity Model VHT, no substitutions.

2.9 FLOW CONTROL VALVE ASSEMBLIES

A. Manufacturers: Griswold® Controls, Nexus Valve or approved. Griswold® Controls model numbers are listed.

B. Description: Flow control piping assemblies for installation in return piping from coils. Flow control valve designed to maintain flow with plus or minus 5 percent of factory calibrated flow rate. Assemblies in return piping to include 2-way and 3-way actuated ball valve as separate component. Actuator analog modulating 4 to 20 mA or 2 to 10 V, 3 point floating, pulse width modulation, or 2 position as indicated on the Drawings. Include universal mounting plate for actuator. Actuator furnished by control subcontractor as specified in Section 230900 for installation at factory by flow control valve assembly manufacturer. Griswold® Controls Unimizer® UR2 Series assembly with 2-way valve or UR3 Series assembly with 3-way valve.

C. Return Connection: Union with temperature/pressure test port at coil connection, flexible hose, union with manual air vent valve, 2-way and 3-way actuated ball valve with mounting plate, flow control valve with cartridge, integral ball valve, and 2 temperature/pressure test ports. Actuator analog modulating 4 to 20 mA or 2 to 10 V, 3 point floating, pulse width modulation, or 2 position as indicated on the Drawings. Include universal mounting plate for actuator. Actuator furnished by control subcontractor as specified in Section 230900 for installation at factory by flow control valve assembly manufacturer. Griswold Controls Unimizer® UR2 Series assembly with 2-way valve or UR3 Series assembly with 3-way valve Construction:

1. Ball Valves: Forged brass alloy body rated no less than 275 psig and 250 F.
2. Strainers: Y-type, forged or cast brass body rated no less than 300 psig with 20 mesh stainless steel screen.
3. Unions: Forged brass body, brass FNTP, SWT, or ProPress end connections, EPDM O-ring, union seal, 600 WOG.
4. Flow Control Valve: Forged or cast brass valve body with removable spring- loaded Type 304 stainless steel flow control cartridge assembly.
5. Actuated Ball Valve: Forged brass housing, dual Teflon and EPDM O-ring stem seals, nickel-plated brass ball, and blow out proof brass stem. Equal percentage flow characteristic. Mounting plate to include shaft and mounting hardware.
6. Valves to include field repairable stem for replacement without draining system. Valve stem to include repairable dual seals (two Teflon® seals and one EPDM O-ring) combined with grease reservoir for resistance to various chemical compounds found in closed hydronic systems.

D. Pressure Range: 2 to 32 psig unless otherwise noted.

E. Temperature/Pressure Test Ports: Comply with requirements in Section 232116.

F. Flexible Hoses: Braided stainless steel over synthetic polymer liner, swivel end connections at coils, ASTM D 380, minimum 175 psig, flame retardant, 18 inch length.

G. Exceptions:

1. Coils with Capacities Greater Than 57 gpm: Separate automatic flow control valve, ball valve, and automatic control valve.
2. Pipe Sizes Exceeding Manufacturer's Available Sizes: Separate valves, automatic flow control valve, strainers, unions, automatic control valves, temperature/pressure test ports, and other components for complete installation.

H. Tags: Include indelibly marked metal tag with Cv, model number, and location.

I. Applications: Unit heaters, cabinet unit heaters, panel radiators, fan coil units, VAV unit and FTU coils, duct mounted coils, and air handling unit coils with capacity less than 57 gpm.

J. Manufacturers: Griswold® Controls, Nexus Valve or approved.

2.10 COLD WATER FILL ASSEMBLIES

A. Description: Automatic fill and make-up water assembly for hydronic system charging and pressure maintenance.

B. Pressure Reducing Valve: Self-contained super capacity regulator, bronze body with screwed ends, replaceable stainless steel seat, replaceable composition disk, 150 psig working pressure, integral strainer with 32 mesh screen, 25 to 75 psig adjustable pressure range, maximum 10 psig pressure drop through the valve and strainer. Watts No. 223S or equivalent.

C. Pressure Relief Valve: Bronze body, Teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labeled. Select for capacity greater than pressure reducing valve capacity. Watts No. 174A Series or equivalent.

D. Manufacturers: Watts®, Mueller Water Products, Armstrong Fluid Technology, or approved.

2.11 AUTOMATIC AIR VENTS

A. Description: Cast brass, rated for 150 psig WSP and 270 F operating temperature. Units with non-ferrous floats, stainless steel linkage, and Viton® seal and brass spring operated seat.

B. Manufacturers: Spirotherm Spirotop Air Release Valve or approved.

2.12 MANUAL AIR VENTS

A. Description: Needle valve, 1/2 inch, with 2 feet of soft drawn copper tubing.

2.13 SIGHT FLOW INDICATORS

A. Description: Paddlewheel indicator for flow in any direction.

B. Constructions: Bronze rated for 180 psig at 300 F for pipe sizes 2 inch and smaller and carbon steel rated for 230 psig at 300 F for pipe sizes 2-1/2 inch and larger. Include flanged ends tempered glass window, Neoprene seals, and Teflon© rotator.

C. Manufacturer: John C. Ernst Co., Inc. Model 241 for pipe sizes 2 inch and smaller and Model 201 for pipe sizes 2-1/2 inch and larger or approved®.

2.14 PIPING SPECIALTIES

A. Pipe Sleeves: Comply with requirements in Section 230510.

B. Section Pipe Hangers and Supports: Comply with requirements in Section 232116.

C. Thermometers and Pressure Gages: Comply with requirements in Section 232116.

D. Pipe Escutcheons: Comply with requirements in Section 232116.

E. Valves: Comply with requirements in Section 232120.

PART 3 - EXECUTION

3.1 INSPECTION

A. General: Verify installation conditions as satisfactory to receive the Work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

3.2 PREPARATION

A. Field Measurements: Field verify locations of new and existing work prior to commencing the Work of this section.

B. Protection: Protect surrounding areas and surfaces to preclude damage from the Work of this section.

3.3 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

A. General: Install, apply, erect, and perform the Work in accordance with Article “Quality Assurance” provisions, specifications, and manufacturer’s installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

B. Do not cover up or enclose work until inspected and approved. If in non-compliance, uncover work, remove, and provide new to satisfaction of the A/E at no additional cost to Owner.

3.4 PIPING INSTALLATION

A. General:

1. Install piping, fittings, and appurtenances in accordance with recognized industry practices which will achieve permanently leakproof piping systems and capable of performing each indicated service without piping failure.
2. Install each run with minimum joints and couplings, but with adequate and accessible unions or flanges for disassembly and maintenance replacement of valves and equipment.
3. Reduce sizes (where indicated) by use of reducing fittings. Bushings not acceptable.

B. Align piping accurately at connections, with 1/16 inch misalignment tolerance.

C. Minimum 3/4 inch pipe size.

D. Install pipe generally sloped to permit drainage at low points, free from sags, bends, and traps, and in a manner to conserve space for other work. Refer to other sections for specific installation requirements.

E. Location of Piping:

1. Piping plans, sections, details, and diagrams are diagrammatic indicating general arrangement of piping installation. Locate piping and include offsets to avoid interference with building structural members, equipment, building openings, light fixtures, ductwork, electrical work, and other obstructions.
2. Arrange piping to allow access for operation, service, disconnection, and removal and replacement of valves, fixtures, and equipment.
3. In general, maintain maximum possible headroom in ways of egress, including pedestrian walkways and maintenance aisles, minimum headroom of 6’-8” from floor to bottom of any component.
4. Within buildings, conceal piping in walls and chases and above ceilings except where indicated in the Contract Documents to remain exposed. Do not cover or enclose work until completely inspected and approved. Should Work be covered or enclosed prior to inspections and approvals, uncover work as directed by the A/E. After the Work has been inspected and approved, make repairs and replacements with materials as necessary to obtain approval of the A/E at no additional cost to the Owner.
5. Route piping parallel to column lines and perpendicular to floor unless indicated otherwise.

F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

G. Install fittings for changes in direction and branch connections.

H. Install piping to allow application of insulation.

I. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

J. Clean interior of piping before making joints and placing in position by blowing clean with steam or compressed air. Maintain cleanliness of piping throughout installation. Install caps or plugs on open ends of cleaned piping.

K. Install isolation valves specified in Section 221120 and drain existing piping to accommodate installation of new Work.

L. Install pipe supports in accordance with MSS SP-58 and Section 232116, whichever is more stringent.

M. Branch Connections to Mains: Connect with tee fittings. On upfed branches, pitch branch piping fitting upward from pipe main. On downfed branches, pitch branch piping fitting downward from pipe main.

N. Coil Connections: Connect counterflow and to allow coils to vent and drain.

O. Pump Connections: Support piping adjacent to pump so that no weight is carried on pump casing.

P. Flow Switches: Install flow switches furnished under Section 236420.

Q. Flexible Connectors: Install flexible connectors furnished under Section 230548 at connections to vibration-isolated (spring and rubber isolator-mounted), chillers, cooling towers, and similar equipment. Install pump discharge flexible connectors furnished under Section 232123 at connections to vibration-isolated (spring and rubber isolator-mounted) pumps.

R. Control Components: Install control and differential pressure valves, water pressure and differential pressure taps, valve manifolds, flow switches, thermal wells, and similar components furnished under Section 230900.

S. Air Vents:

1. Automatic Air Vents: Install at high points of hydronic piping systems unless otherwise indicated on the Drawings. Connect inlet through gate or ball valve. Install 1/4 inch copper discharge pipe from threaded outlet and terminate over floor drain, service sink, or other safe point of disposal.
2. Manual Air Vents: Install as indicated on the Drawings.

T. Valves: Install at branch connections in addition to valves at flow control valve assemblies.

3.5 DIELECTRIC UNIONS

A. Install at the Following Locations:

1. At black and galvanized steel piping connections to copper tubing.
2. At black steel piping connections to copper headers for coils installed in air handling units, fan coil units, air terminal boxes, and duct mounted heating and cooling coils.
3. At black steel piping connections to bronze valves and similar devices.

3.6 SCREWED JOINTS

A. Use threads on iron and steel pipes, fittings and couplings in accordance with ASME B31.1.

B. Produce sufficient lengths of high quality threads to insure full metal-to-metal contacts when screwed home in fittings. Countersink, ream and clean ends of pipes after threading.

C. Make up full connections with not more than 3 full threads exposed, by such method that will not subject pipes or fittings to twisting or cross strains. Lubricate male threads with thread lubricant or pipe joint tape.

D. Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

E. Use sealants which are chemically resistant to glycol on metal piping threads. Use sealants sparingly and apply to only male threads of metal joints.

3.7 SOLDERED AND BRAZED JOINTS

A. Comply with applicable provisions of ASTM B 828 or “Copper Tube Handbook” by CDA for soldered joints and “Brazing Handbook” by AWS for brazed joints.

B. Cut ends square and remove fins and burrs. Replace dents and damaged tubing with new tubing.

C. Remove grease and oil from joints by wiping with clean cloth saturated with suitable chemical solvent. Clean with emery cloth.

D. After cleaning, apply non-corrosive flux, apply heat and material and hold joint rigidly until hardened.

E. Wipe excess material from exterior of joint before hardening.

F. Before soldering and brazing, remove stems and washers of valves.

G. Braze 2-1/2 inch and larger piping unless copper press fitting couplings are used.

3.8 WELDED JOINTS

A. Weld 3 inch and larger steel piping, (and shaped nipples to existing piping for connection of new piping). Construct joints according to AWS D10.12.

B. Bevel piping ends mechanically or by flame cutting. Where beveling is done by flame cutting, thoroughly clean surfaces of scale and oxidation just prior to welding.

C. Do not split, bend, flatten or otherwise deform piping before, during, or after installation. During erection, take care to remove dirt, scale, and other foreign matter from inside piping by use of pipe swab or pipe “pig” before connecting sections, valves, equipment, and fittings. Where pipe temperature falls to 32 F or lower, heat pipe to approximately 100 F for distance of 1 foot each side of weld before welding, and finish weld before pipe cools to 32 F.

D. Replace defective welds at no additional cost to the Owner. Do not repair by adding weld material over defect or by peening.

3.9 GROOVED JOINTS

A. Allowed beyond 30 linear feet from connections to boilers and heat exchangers.

B. Cut or roll grooves in ends of pipe based on pipe and couplings manufacturer's written instructions for pipe wall thickness.

C. Assemble joints with coupling and gasket, lubricant, and bolts.

D. Use grooved-end fittings and rigid, grooved-end-pipe couplings.

E. Install new gaskets when existing couplings are disassembled.**]**

3.10 COPPER PRESS FITTING COUPLINGS

A. Use manufacturer-recommended tool and procedure. Leave insertion marks on pipe after assembly.

3.11 FLANGED JOINTS

A. Match flanges within piping system, and at connections with valves and equipment.

B. Clean flange faces and install gaskets concentrically positioned.

C. Use suitable lubricants on bolt threads and tighten bolts to provide uniform compression of gaskets.

3.12 MECHANICAL EQUIPMENT CONNECTIONS

A. Connect hydronic piping to mechanical equipment coils, traps, control valves, and other components as indicated on the Drawings. Comply with equipment manufacturer's installation instructions. Install shutoff valve and union or flanges for each connection and drain valve on drain connection. Locate unions to allow removal of equipment without piping disassembly beyond union.

3.13 CLEANING AND INSPECTING

A. Clean exterior surfaces of installed piping systems of superfluous materials, and prepare for application of specified coatings (if any).

B. Inspect each run of each system for completion of joints, supports, and accessory items.

C. Inspect pressure piping in accordance with procedures of ASME B31.1 and ASME B31.9.

3.14 FLUSHING

A. Flush piping with clean water prior to connecting to existing systems and pressure testing.

B. Isolate equipment from piping during flushing. Provide bypass piping and remove after flushing is completed. Provide cap, plug, or blind flange at pipe connections.

C. Remove strainer screens during flushing except those protecting control equipment. Clean screens protecting control equipment during flushing and after flushing is completed. Coordinate with controls system subcontractor to have automatic control valves fully open during flushing.

D. Flush designated piping systems by circulating water through 100 mesh screen at 7-1/2 feet per second for 1 hour minimum.

E. Flush heating water, chilled water, condenser water, heat recovery piping.

F. Following initial flushing but before the systems are refilled, reinstall strainer screens, coordinate with chemical treatment specialist specified in Section 232500 and provide assistance with chemical cleaning and addition of chemical treatment to systems.

3.15 PRESSURE TESTING

A. Provide equipment and apparatus necessary for tests. Make tests in presence of the A/E. Notify the A/E at least 48 hours before expected tests.

B. Test piping systems before insulation has been applied, and before backfilling.

C. Test Pressures and Duration: Test piping systems at pressure of 1-1/2 times design working pressure or at 100 psig, whichever is greater. Maintain test pressure for sufficient time to permit complete inspection of system under test. Minimum 2 hour duration. Test in sections and test entire system when completely installed.

D. Test Procedure:

1. Before tests, remove or valve off from the system gages, traps, pressure reducing valves, pumps, and other apparatus which may be damaged by test pressure.
2. Install calibrated test pressure gage in system to observe any loss in pressure.
3. Test piping at metal temperature greater than 35 F.
4. Open vents, and other connections which can serve as vents, during filling so that air is vented prior to applying test pressure to system.

E. Testing Media Requirements:

1. Use clean, fresh city water for hydrostatic testing. Water temperature shall be not less than 60 F and not greater than 100 F.
2. Drain water immediately after hydrostatic testing. Vent system while draining to avoid creating a vacuum.

F. Test Repairs:

1. Remove materials such as gaskets and bolts damaged during tests and flushing and provide new components.
2. Use new gaskets each time a flanged joint is made up.

3. Repair defects which develop during testing and retest piping systems until they show no defect or weakness and are tight. Do not use chemicals, stop-leak compounds, mastics, or other temporary repair methods.

G. Test Records: Make and submit records for each piping installation.

H. Include at a minimum, the following items:

1. Date of test.
2. Description and identification of piping tested.
3. Test fluid.
4. Test pressure.
5. Test duration.
6. Remarks to include such items as: Leaks (type, location); repairs made on leaks.
7. Signature and date of person witnessing the test.
8. Certification by the Contractor.

I. Systems Which Connect to Existing Piping: Isolate new piping system from existing system by the closest valve or valves to the existing system.

3.16 WATER TREATMENT EQUIPMENT

A. General: Install equipment and associated components furnished under Section 232500 in accordance with water treatment specialist's directions and recommendations.

3.17 HVAC SYSTEMS TRAINING

A. Comply with requirements in Section 230810.

3.18 COMMISSIONING

A. Equipment and systems referenced in this section shall be commissioned per Section 230800. The Contractor has specific responsibilities for scheduling, coordination, test development, testing and documentation.

END OF SECTION 232113

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Description: The Work includes pipe specialties that apply to multiple systems. Specialty components specific to single system are specified in that particular section.

B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to the Work in this section.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.

B. Codes and Standards:

1. ASME B31.1, Power Piping.
2. ASTM A 36, Standard Specification for Carbon Structural Steel.
3. ASTM A 53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
4. ASTM A 666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
5. ASTM B 650, Standard Specification for Electrodeposited Engineering Chromium Coatings on Ferrous Substrates.
6. ASTM E 84, Standard Test Method for Surface Burning Characteristics of Building Materials.
7. MSS SP-58, Pipe Hangers and Supports – Materials, Design, Manufacture, Selection, Application, and Installation.
8. NFPA 255, Surface Burning Characteristics Building Materials.
9. UL 536, Standard for Flexible Metallic Hose.
10. UL 723, Tests for Surface Burning Characteristics of Building Materials.

C. Pipe hangers and clamps and related components installed in ceiling spaces used as a return air plenum shall have ratings per NFPA 255, ASTM E 84, and UL 723 with flame spread rating not greater than 25 and smoke developed rating not greater than 50.

1.3 SUBMITTALS

A. Comply with requirements in Division 01 and Section 230500.

B. Product Data: Submit manufacturer's technical product data and maintenance data for the following. Include MSS reference in product data for pipe hangers and supports.

1. Pipe hangers and supports.
2. Engineered secondary pipe positions and support systems.
3. Pipe supports on roof.

4. Insulated pipe hangers.
5. Y-type strainers.
6. Thermometers.
7. Pressure gages.
8. Temperature/pressure test ports.
9. Thermal/seismic flexible loops.
10. Seismic flexible loops.
11. Alignment guides.
12. Thermal expansion joints.
13. Pipe anchors.
14. Pipe wrap.
15. Pipe escutcheons.

PART 2 - PRODUCTS

2.1 GENERAL

A. Furnish factory-fabricated piping specialties recommended by manufacturers for use in services indicated. Furnish piping specialties of types and pressure ratings indicated but rated at not less than 125 psig WSP to comply with installation requirements. Furnish sizes as indicated with connections which properly mate with pipe, tube, and equipment connections. Where more than one type is indicated, selection is Contractor's option. Refer to other sections for higher working steam pressures.

B. Except as otherwise indicated, furnish factory-fabricated pipe hangers and supports complying with MSS SP-58, of one of the following MSS types listed, selected to suit piping systems, in accordance with MSS SP-58 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hangers and supports to exactly fit around piping insulation with saddle and shield for insulated piping and where insulated pipe hangers are used.

C. Materials: Match piping material at point of contact with piping:

1. Carbon steel, cast or malleable iron for black steel pipe.
2. Carbon steel, cast or malleable iron with epoxy coating galvanized steel pipe and zinc coating for piping installed outdoors.
3. Carbon steel or malleable iron with copper finish or plastic coated, or copper for copper pipe.

2.2 PIPE HANGERS AND SUPPORTS

A. Horizontal Piping:

1. Adjustable Steel Clevises: MSS SP-58 Type 1.
2. Yoke Type Pipe Clamps: MSS SP-58 Type 2.
3. Steel Pipe Clamps: MSS SP-58 Type 4.
4. J-Hangers: MSS SP-58 Type 5.
5. Adjustable Band Hangers: MSS SP-58 Type 9.
6. Split Pipe Rings: MSS SP-58 Type 11.

7. Pipe Slides and Slide Plates: MSS SP-58 Type 35, including glide type plate.
8. Adjustable Roller Hanger: MSS SP-58 Type 43.
9. Adjustable Pipe Roll and Base: MSS SP-58 Type 46.
10. Trapeze Hanger: MSS SP-58 Type 59, shop or field fabricated made from structural-steel shapes with hanger rods, nuts, saddles, and U-bolts. Comply with requirements in Section 200510 for formed steel channels.
11. Finish: Galvanized steel.

B. Hanger Rods: Hot rolled steel, ASTM A 36. Refer to Article “Hanger Rod Schedule” in this section.

C. Vertical Pipes at Walls and Columns: Supporting pipes from walls and columns not acceptable.

D. Riser Clamp for Vertical Pipes between Floors: MSS SP-58 Type 8 and Type 42.

E. Hanger Rod Attachments:

1. Steel Turnbuckles: MSS SP-58 Type 13.
2. Steel Clevises: MSS SP-58 Type 14.

F. Building Attachments:

1. Steel or Malleable Concrete Inserts: MSS SP-58 Type 18 or UL listed.
2. Top Beam C-Clamps: MSS SP-58 Type 19.
3. Side Beam or Channel Clamps: MSS SP-58 Type 20.
4. C-Clamps: MSS SP-58 Type 23.

G. Cushion Clamp for Un-Insulated Pipes:

1. Description: Steel clamp assembly with cushion insert for use with formed steel channels. Clamp with electro-galvanized finish. Cushion insert manufactured from thermoplastic elastomer for temperature range from 50 F to 300 F. Unistrut Cush-A-Clamp or approved.

H. Manufacturers: Anvil International, Unistrut®, Power-Strut®, Superstrut®, PHD Manufacturing Inc., Cooper Industries B-Line, TOLCO™, Simpson Strong-Tie, or approved.

2.3 ENGINEERED SECONDARY PIPE POSITIONING AND SUPPORT SYSTEMS

A. General: Support of piping accomplished by engineered products specific to each application. Typical applications:

1. Vertical and horizontal branch piping serving plumbing fixtures.
2. Piping penetrations through wood and steel stud framing.
3. Trapeze hanger with horizontal piping either above or below the strut.

B. Manufacturers: HOLDRITE® or approved.

2.4 INSULATED PIPE HANGERS

A. Description: Hydrous calcium silicate or polyisocyanurate foam (urethane) insulation which covers 100 percent of the pipe and extends beyond overlapping full wrap galvanized steel or PVC jacket. Thickness of insulation same as specified in Section 230700 for specific pipe systems.

B. Manufacturers: KB Enterprises SNAPP ITZ for both hot and cold pipe applications or approved.

2.5 Y-TYPE STRAINERS

A. Description: Line size of connecting piping with ends matching piping system materials. Select strainers for minimum 125 psi working pressure. Include ASTM A 666 Type 304 stainless steel screens, unless specified otherwise, with 3/64 inch perforations at 233 per sq. in. and blowout connection with ball valve and capped nipple or gate valve with plug.

1. Threaded Ends, 2 Inch and Smaller for Steel Pipe: Cast iron body.
2. Threaded or Solder Ends, 2 Inch and Smaller for Copper Pipe: Cast bronze body with brass screen.
3. Flanged Ends, 2-1/2 Inch and Larger: Cast-iron body.
4. Grooved ends, 2 Inch and Larger: Ductile iron body.
5. Manufacturers: Armstrong Fluid Technology, Watts®, Crane, Hoffman Specialty®, Victaulic Co., Metraflex, Spirax Sarco, Nibco, or approved.

2.6 THERMOMETERS

A. Description: Solar powered, 3/8 inch LCD digital display at 1 foot-candle, 1 percent or 1 degree (whichever is greater accuracy), minus 40 F to 300 F temperature range, recalibration by internal potentiometer. ABS case construction. Adjustable stem assembly, 3-1/2 or 6 inch length to suit installation requirements.

B. Manufacturers: Weiss Instruments Inc. DVU Series or approved.

2.7 PRESSURE GAGES

A. Description: Solar powered, 5/8 inch LCD digital display at 1 foot-candle, 1/4 percent (first half) and 1/2 percent (second half) resolution, 0.5 percent accuracy over full scale, minus 15 F to 150 F temperature range. 41/2 inch round case with black safety glass and solid front. Adjustable stem assembly. Adjustable range.

B. Manufacturers: Weiss Instruments DUGY Series or approved.

2.8 TEMPERATURE/PRESSURE TEST PORTS (PETE'S PLUGS)

A. Description: Brass, 1/4 inch NPT with extension for insulated piping, length to suit insulation thickness.

B. Manufacturers: Peterson Equipment Company, Inc. Pete's Plug® II, Sisco P/T Plug, or approved.

2.9 PIPE WRAP

A. Description: 10 mil thick vinyl, minimum 3 inch wide.

B. Manufacturer: Lone Star Specialties Trantex Tapes VID-10 or approved.

2.10 PIPE ESCUTCHEONS

A. Description: Select with inside diameter closely fitting pipe outside diameter, or outside of pipe insulation where pipe is insulated, and to completely cover pipe penetration hole in floors, walls or ceilings including pipe sleeve extension. Nickel or chrome finish for occupied areas and prime paint finish for unoccupied areas.

1. Pipe Escutcheons for Moist Areas: For water-proof floors and areas where water and condensation can be expected to accumulate, cast brass or sheet brass escutcheons, solid or split hinged.
2. Pipe Escutcheons for Dry Areas: Sheet steel escutcheons, solid or split hinged.

PART 3 - EXECUTION

3.1 INSPECTION

A. General: Verify installation conditions as satisfactory to receive work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

3.2 PREPARATION

A. Field Measurements: Field verify locations of new and existing the Work prior to commencing work of this section.

B. Protection: Protect surrounding areas and surfaces to preclude damage from the Work of this section.

3.3 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

A. General: Install, apply, erect, and perform the Work in accordance with Article “Quality Assurance” provisions, specifications, and manufacturer’s installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

3.4 PIPE HANGERS AND SUPPORTS

A. General: Install building attachments at required locations for piping support. Install additional supports at concentrated loads, including valves, flanges, guides, strainers, expansion joint and at changes in direction of piping. Install insulated pipe hangers for all insulated pipes.

B. Install hangers, supports, clamps, attachments and engineered secondary pipe positioning and support systems to support piping securely from building structure. Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible, MSS SP-58 Type 59. Where piping of various sizes are supported by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Use of wire, perforated metal or scrap framing materials to support piping not acceptable.

C. Install hangers and supports complete with necessary insert, bolts, rods, nuts, washers and other accessories. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.

D. Spacing of Hangers and Supports:

1. Maximum spacing between supports for straight runs of piping listed in Article “Spacing of Hanger and Supports Schedule” in this section.

E. Pipe Ring Diameter:

1. Uninsulated Pipes: Ring diameter to suit pipe size.
2. Insulated Pipes: Ring diameter to suit outer diameter of insulated pipe hanger.

F. Anchoring, Guiding, and Supporting Piping:

1. Anchor and support piping so that expansion and contraction will take place in direction desired without stressing pipe, joints, and connected equipment.
2. Prevent vibration with vibration dampers and prevent undue strains on equipment served.
3. Fabricate hangers used for support of 2 inch nominal pipe size and larger to permit adequate adjustment after erection while still supporting the load.
4. Use wall brackets where pipes are adjacent to walls or other vertical surfaces which may be used for supports.
5. Fabricate supports to carry weight of piping and fluid and to maintain proper alignment.
6. Install inserts for supports in concrete. Powder-actuated inserts not allowed.
7. Install pipe rollers, alignment guides, and anchors at points where necessary to keep pipes in accurate alignment, to direct expansion movement, to prevent buckling, swaying and undue strain, and per expansion joint manufacturer’s instructions.
8. Install hangers and supports for indicated pipe slope, and so that maximum pipe deflections allowed by ASME B31.1 are not exceeded.
9. Hang individual pipes and multiple pipes by trapeze hangers separately from roof structure and not from the roof deck itself and not from work of other trades. Hanging pipes from ducts and equipment not acceptable.
10. Install formed steel channel as specified in Section 230510 where required for pipe hangers and supports.
11. Install supports for horizontal pipe within 1-1/2 inch of each elbow.

3.5 PIPE HANGER AND SUPPORT APPLICATIONS

A. Horizontal Piping: Unless otherwise indicated, install the following types:

1. Adjustable Steel Clevis Hangers (MSS SP-58 Type 1): For suspension of noninsulated or insulated stationary pipes.
2. Yoke Type Pipe Clamps (MSS SP-58 Type 2): For suspension of 120 F to 450 F pipes, 4 to 16 inch sizes, requiring up to 4 inch of insulation.
3. Steel Pipe Clamps (MSS SP-58 Type 4): For suspension of cold and hot pipes, 1/2 to 24 inch sizes, if little or no insulation is required.
4. J-Hangers (MSS SP-58 Type 5): For suspension of pipes, 1/2 to 4 inch sizes, to allow off-center closure for hanger installation before pipe erection.
5. Adjustable Band Hangers (MSS SP-58 Type 9): For suspension of noninsulated stationary pipes, 1/2 to 8 inch sizes.
6. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS SP-58 Type 11): For suspension of noninsulated stationary pipes, 3/8 to 8 inch sizes.
7. Adjustable Roller Hangers (MSS SP-58 Type 43): For suspension of pipes, 2-1/2 to 20 inch sizes, from single rod if horizontal movement caused by expansion and contraction might occur.
8. Adjustable Pipe Roll and Base Units (MSS SP-58 Type 46): For support of pipes, 2 to 30 inch sizes if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

B. Vertical-Piping Clamps: Unless otherwise indicated, install the following types:

1. Extension Pipe or Riser Clamps (MSS SP-58 Type 8): For support of pipe risers, 3/4 to 20 inch sizes.
2. Carbon- or Alloy-Steel Riser Clamps (MSS SP-58 Type 42): For support of pipe risers, 3/4 to NPS 20 inch sizes, if longer ends are required for riser clamps.

C. Hanger-Rod Attachments: Unless otherwise indicated, install the following types:

1. Steel Turnbuckles (MSS SP-58 Type 13): For adjustment up to 6 inch for heavy loads.
2. Steel Clevises (MSS SP-58 Type 14): For 120 F to 450 F piping installations.

D. Building Attachments: Unless otherwise indicated, install the following types:

1. Steel or Malleable Concrete Inserts (MSS SP-58 Type 18 or UL listed): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS SP-58 Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS SP-58 Type 20): For attaching to bottom flange of beams, channels, or angles.
4. C-Clamps (MSS SP-58 Type 23): For structural shapes.

3.6 LOW PRESSURE Y-TYPE STRAINERS

A. Install strainers full size of pipelines, in pipe ahead of the following items and equipment, and elsewhere as indicated, if integral strainer is not included:

1. Pumps, unless pump is equipped with a suction diffuser.

2. Control valves.
3. Pressure regulators.

3.7 THERMOMETERS

A. Install at the Following Locations:

1. Inlet and outlet of equipment where fluid changes temperatures except where temperature/pressure test ports are indicated on the Drawings.
2. Other locations as indicated on the Drawings.

B. Thermal Wells: Install in piping so that thermometer scale is readable by personnel from a normal standing position on floor or grating. Fill thermal well with heat transfer medium approved by thermometer manufacturer.

3.8 PRESSURE GAGES

A. Install at the Following Locations:

1. On suction and discharge of pumps except domestic hot water circulators. Inlet to pump suction diffuser or pump strainer. Install single pressure gage connected through gage valves to suction and discharge connections of each pump and to inlet of pump suction diffuser or pump strainer. Assembly consists of nipples at tappings, needle (gage) valves, couplings, snubbers, and tee into gage.
2. Inlet to domestic water service.
3. Inlet and outlet of pressure reducing valves.
4. Inlet and outlet of reduced pressure backflow preventers.
5. Other locations as indicated on the Drawings.

B. Installation: Install (gage) needle valve, and snubber so gage dial is readable by personnel from normal standing position on floor or grating.

3.9 TEMPERATURE/PRESSURE TEST PORTS (PETE'S PLUGS)

A. Installation: Install so that thermometer dial and pressure gage can be inserted and easily readable by personnel from normal standing position on floor or grating. Where installed in insulated pipes, install with coupling to extend test port through insulation and jacket.

B. Installations at Equipment: Install immediately adjacent to equipment such that there are no fittings between test port and final equipment connection point.

C. Installation at Miscellaneous Devices: Install immediately adjacent to sensors, pressure gages, and thermometers.

D. Tag: 1-1/2 inch round tag, 19 gage brass with 1/4 inch letters, labeled "TEST TAP". Attach with brass chain.

3.10 THERMAL/SEISMIC FLEXIBLE LOOPS, SEISMIC FLEXIBLE LOOPS, AND THERMAL EXPANSION JOINTS

A. Install thermal/seismic flexible loops, seismic flexible loops, and thermal expansion joints for each service as indicated on the Drawings.

B. Remove shipping bars after installation of thermal expansion joints but prior to pressure testing.

C. Install support of return bend of U and V style flexible loops per manufacturer's instructions to be in neutral condition.

D. Support non-parallel leg in 3-legged flexible loop design at each elbow using manufacturer furnished hanger assembly kit.

E. Install alignment guides and anchors to direct movement axially into thermal/seismic flexible loop, seismic flexible loop, and thermal expansion joint as required by manufacturer.

3.11 ALIGNMENT GUIDES

A. Install guides on piping adjoining thermal/seismic flexible loops and thermal expansion joints as required by manufacturer

B. Attach guides to pipe and secure to building structure.

3.12 PIPE WRAP

A. Double wrap underground steel piping and fittings, including riser, to a minimum of 6 inch above grade. Clean and prime before wrapping. Complete pressure testing prior to wrapping.

B. Factory Applications: Provide factory-applied wrapping for straight lengths of pipe, applied spirally wound with half-overlapping. Hold-back not less than 4 inch on each end for field welding.

C. Field Applications: Field wrap fittings and field joints. Initially stretch tape to conform with surface while spirally half-overlapping for total of 4 thicknesses. Overlap factory-wrapped pipe wrapping minimum of 6 inch.

D. Inspection:

1. Inspect wrapped surfaces for film thickness and uniformity of tape application.
2. Test wrapped surfaces in their entirety for presence of flaws with electrical flaw and holiday detector at crest voltage of 5000 V.
3. Provide calibrated instrument incapable of field adjustment, with calibration within previous 6 months certified by manufacturer or by acceptable testing laboratory (e.g., National Bureau of Standards).
4. Perform test before and after installation. Repair defects and repeat tests.

3.13 PIPE ESCUTCHEONS

A. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings. Escutcheons not required where sleeves project above floor.

3.14 COMMISSIONING

A. Equipment and systems referenced in this section shall be commissioned per Section 230800. The Contractor has specific responsibilities for scheduling, coordination, test development, testing and documentation.

3.15 HANGER ROD SCHEDULE

ROD DIAMETER (INCH)	PIPE SIZE (INCH)	LOAD AT 650 F (POUNDS)
3/8	2 and smaller	730
1/2	2-1/2 and 3-1/2	1,350
5/8	4 and 5	2,160
3/4	6	3,230
7/8	8 to 12	4,480
1	14 to 18	5,900
1-1/4	20 to 24	9,500

3.16 SPACING OF HANGERS AND SUPPORTS SCHEDULE

PIPE SIZE (INCH)	STEEL AND IRON PIPE MAXIMUM SPAN (FEET)		COPPER TUBING MAXIMUM SPAN (FEET)	
	WATER SERVICES	STEAM, GAS, AND AIR SERVICES	WATER SERVICES	GAS AND AIR SERVICES
1/2 and smaller	7	8	5	6
3/4	7	9	5	7
1	7	9	6	8
1-1/4	7	9	7	9
1-1/2	9	12	8	10
2	10	13	8	11
2-1/2	11	14	9	13
3	12	15	10	14
4	14	17	12	16
6	17	21		
8	19	24		
10	22	26		
12	23	30		
14	25	32		
16	27	35		
18	28	37		

PIPE SIZE (INCH)	STEEL AND IRON PIPE MAXIMUM SPAN (FEET)		COPPER TUBING MAXIMUM SPAN (FEET)	
	WATER SERVICES	STEAM, GAS, AND AIR SERVICES	WATER SERVICES	GAS AND AIR SERVICES
20	30	39		
24	32	42		

END OF SECTION 232116

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Description: The Work includes valves and associated appurtenances for hydronic systems. Valves specific to single system are specified in that particular section.

B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to the Work in this section.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.

B. Codes and Standards:

1. ASME B31.1, Power Piping.
2. ASTM A 126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
3. ASTM B 61, Standard Specification for Steam or Valve Bronze Castings.
4. ASTM B 62, Standard Specification for Composition Bronze or Ounce Metal Castings.
5. ASTM B 584, Standard Specification for Copper Alloy Sand Castings for General Applications.

1.3 SUBMITTALS

A. Comply with requirements in Division 01 and Section 230500.

B. Product Data: Submit manufacturer’s technical product data and maintenance data for the following:

1. Gate valves.
2. Ball valves.
3. Globe valves.
4. Swing check valves.
5. Non-slam check valves.
6. Butterfly valves.
7. Drain valves.
8. Balancing valves.
9. Relief valves.
10. Pressure reducing valves.
11. Valve operators.

PART 2 - PRODUCTS

2.1 GENERAL

A. Furnish factory-fabricated valves recommended by manufacturer for use in service indicated. Furnish valves of types and pressure ratings indicated but rated at not less than 125 psig WSP to comply with installation requirements. Furnish sizes as indicated with connections which properly mate with pipe, tube, and equipment connections. Where more than one type is indicated, selection is Contractor's option. Refer to other sections for higher working steam pressures.

B. Grooved Joint Valves: Use with grooved joint piping systems as specified in Section 232113 for sizes 2-1/2 inch and larger.

C. Manufacturers: Victaulic Co., Fairbanks, Hammond Valve, Red-White Valve Corp., Jenkins, Milwaukee Valve Co., Metraflex Co., NIBCO, Powell, Stockham, Walworth Valves, DFT® Inc., Jomar Group, or Apollo/Conbraco.

2.2 GATE VALVES

A. General: Select valves designed for repacking under pressure when fully opened, equipped with packing suitable for intended service. Select valves designed so back seating protects packing and stem threads from fluid when valve is fully opened. Equip with gland follower. Comply with the following standards:

1. Bronze Valves: MSS SP-80.
2. Cast Iron Valves: MSS SP-70.

B. 2 Inch and Smaller: Bronze, solid bronze wedge disc, nonrising stem, screwed or soldered joint ends, union bonnet, ASTM B 62.

C. 2-1/2 Inch and Larger: Cast iron body, solid wedge disc, bronze trim, flanged, OS&Y, bolted bonnet, ASTM A 126.

2.3 BALL VALVES

A. General: Select with port area equal to or greater than connecting pipe area, include seat ring designed to hold sealing material. Comply with MSS SP-110.

B. Bronze body, 600 pound, chrome plated ball and stem, full port, screwed or solder joint ends, 2 piece construction, lever handle, Teflon seat and seal, memory stop, ASTM B 61, ASTM B 62, or ASTM B 584. Include extended stem, protective sleeve, and fully adjustable memory stop after insulation is applied where valves are insulated.

2.4 GLOBE VALVES

A. General: Select valves designed for repacking under pressure when fully opened, equipped with packing suitable for intended service. Select valves designed so back seating protects

packing and stem threads from fluid when valve is fully opened. Equip with gland follower. Include suitable composition disc material for intended service. For steam throttling service, fit composition disc valve with throttling nut. For metal seated valves, include hardened stainless steel disc and seat ring. Comply with the following standards:

1. Bronze Valves: MSS SP-80.
2. Cast Iron Valves: MSS SP-85.

B. 2 Inch and Smaller: Bronze, composition disc, 4-pattern, screwed or soldered joint ends, union bonnet, ASTM B 62.

C. 2-1/2 Inch and Larger: Cast iron body, bronze trim, screwed-in brass body seat ring, solid bronze disc, bronze stem, flanged, ASTM A 126.

2.5 SWING CHECK VALVES

A. General: Construct valves of pressure castings free of impregnation materials. Include stop plug as renewable stop for disc hanger. Construct disc and hanger as separate parts, with disc free to rotate. Support hanger pins on both ends by removable side plugs. Comply with the following standards for design, workmanship, material and testing:

1. Bronze Valves: MSS SP-80.
2. Cast Iron Valves: MSS SP-71.

B. 2 Inch and Smaller: Bronze, screwed cap, bronze or brass swing disc, Y-pattern, screwed or solder joint ends, ASTM B 62.

C. 2-1/2 Inch and Larger: Cast iron body, flanged, bolted cap, swing pattern, ASTM A 126, renewable cast iron disc with bronze disc face ring and seat to ASTM B 584 except valves larger than 4 inch may be furnished with cast iron disc to ASTM A 126.

2.6 NON-SLAM CHECK VALVES

A. For vertical upward fluid flow. Comply with the following standards:

1. Bronze Valves: MSS SP-80.
2. Cast Iron Valves: MSS SP-125.

B. 2 Inch and Smaller: Brass body, screwed or solder joint ends, Type 304 stainless steel or bronze spring and brass disc holder, PTFE or Buna-N disc, ring, ASTM B 61 or ASTM B 62. Cast iron valves, ASTM A 126, acceptable.

C. 2-1/2 Inch and Larger: Cast iron body, clear or full waterway, globe style, flanged, bronze trim, stainless steel spring and screw, ASTM A 126.

2.7 DRAIN VALVES

A. Bronze body, composition disc, 3/4 inch handwheel, screwed or solder joint ends hose thread outlet with cap. At Contractor option, full port ball valve acceptable.

2.8 BALANCING VALVES

A. Description: Valves for precise flow measurement and balancing with minimum of one 360 degree turn of handwheel. Positive shutoff.

B. Construction: Globe style design, non-ferrous metal parts, Teflon disc ring, meter connections for portable differential pressure meter with integral shutoff valves, calibrated handwheel with adjustment scale, locking memory stop.

C. Sizing: Size smaller than line size to result in minimum 1 foot pressure drop at design flow as close to line size as possible.

D. Manufacturers: Armstrong Fluid Technology CBV-T, -G, or -A, Victaulic Co., or Amtrol. Other manufacturers not acceptable.

2.9 RELIEF VALVES

A. General: CSA code listed and rated. Select capacity to exceed rating of connected equipment. Type as indicated on the Drawings. Cash Acme®, Watts Water Technologies Inc., or approved.

2.10 PRESSURE REDUCING VALVES

A. General: Water regulators with associated integral factory or field installed strainer with 32 mesh screen, 250 psig minimum working pressure, 25 to 100 psig adjustable pressure range, maximum 10 psig pressure drop through valve and strainer.

B. 3 Inch and Smaller: Bronze body with screwed ends, renewable stainless steel seat, and replaceable composition disc. Watts Water Technologies Inc. No. 223SHP, Cash Acme®, Zurn-Wilkins, or approved.

C. 4 Inch and Larger: Cast iron body with flanged ends, renewable stainless steel seat, and replaceable composition disc. Include plugged tappings and 3/4 inch low demand auxiliary regulator. Watts Water Technologies Inc. No. 127W, Cash Acme®, Wilkins, or approved.

2.11 VALVE OPERATORS

A. Valves in Mechanical and Boiler Rooms and Above Suspended Ceilings: Include valve with chain operator complete with sprocket rim and chain guide and hot dipped galvanized chain for valves 4 inch and larger in mechanical rooms and boiler rooms and for valves 2-1/2 inch and larger where installed above suspended ceilings.

PART 3 - EXECUTION

3.1 INSPECTION

A. General: Verify installation conditions as satisfactory to receive the Work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

3.2 PREPARATION

A. Field Measurements: Field verify locations of new and existing work prior to commencing the Work of this section.

B. Protection: Protect surrounding areas and surfaces to preclude damage from the Work of this section.

3.3 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

A. General: Install, apply, erect, and perform the work in accordance with Article “Quality Assurance” provisions, specifications, and manufacturer’s installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

3.4 INSTALLATION

A. Install valves where required for proper operation of piping and equipment, including valves in branch lines to isolate sections of piping. Locate valves to be accessible. Install gate valves 6 inch and larger with separate support so that valve weight is not imposed on adjacent piping.

B. Valve Stem Position:

1. Gate, Globe, and Ball Valves: Install horizontal or above.

C. Check Valves:

1. Swing type check valves installed in vertical pipes not acceptable.
2. Install non-slam type check valves in pump discharge pipes and in vertical pipes.

D. Install isolation valves where indicated on the Drawings and in the following locations:

1. Branch lines.
2. Branch mains.
3. At connections to equipment, such as coils and control valves.

E. Install drain valves at low points of hydronic systems, and as indicated on the Drawings.

F. Install balancing valves with reducers upstream and downstream of valve connections. Install valves with straight pipe upstream and downstream as required by manufacturer’s installation instructions.

G. Install isolation valves upstream of balancing valves.

H. Install valve operators with chains for valves located with horizontal centerline more than 7 feet above floor and where installed with horizontal centerline more than 6 inch above suspended ceilings. Terminate chain 4 feet above floor and 6 inch above ceiling.

I. Install 12 inch long orange colored 1/2 inch wide surveyors tape on valves located above ceilings.

J. Grooved Joint Valves: Use only for grooved joint piping systems specified in Section 232113.

3.5 HVAC SYSTEMS TRAINING

A. Comply with requirements in Section 230810.

3.6 COMMISSIONING

A. Equipment and systems referenced in this section shall be commissioned per Section 230800. The Contractor has specific responsibilities for scheduling, coordination, test development, testing and documentation.

END OF SECTION 232120

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Description: The Work includes pumps and associated appurtenances.

B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to the Work in this section.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.

1.3 SUBMITTALS

A. Comply with requirements in Division 01 and Section 230500.

B. Product Data: Submit manufacturer's technical product data and maintenance data for the following including each type of piping, fittings, and associated appurtenances.

1. Base mounted pumps, horizontal, flexible coupled.

C. Pump Curves: Submit head, efficiency, brake horsepower, and NPSH curves compared to capacity for each pump and for combined pumps operating in parallel or series. Plot curves from zero to maximum flow. Indicate pump operating point. Identify pump equipment number, fluid pumped, specific gravity, pump speed, and impeller size. Submit family of impeller curves for selected pump size. A single pump curve not acceptable.

D. Test Reports:

1. Start-up and test reports. Submit completed copy of report and include copy in the Operations and Maintenance Manual.

PART 2 - PRODUCTS

2.1 SELECTION

A. Select pumps mid-range of available impeller diameters for a given pump, at no less than 2/3 flow rate at maximum efficiency, and with a drive motor sized to operate non-overloading at any point on pump curve for impeller selected.

B. Select pump casing sized large enough to accommodate impeller at least 1 cataloged diameter larger than size of impeller to be furnished.

C. Select pump for maximum 15 feet per second discharge velocity.

2.2 BASE MOUNTED PUMPS, HORIZONTAL, FLEXIBLE COUPLED

A. Description: Centrifugal, flexible coupled, end-suction or double-suction as indicated on the Drawings, horizontal split case, bronze or stainless steel-fitted, single stage, electric motor-driven.

B. Construction: Cast iron casing, bronze or stainless steel impeller, carbon steel shaft, bronze sleeve, ball bearings, flanged connections.

C. Shaft Seals: Mechanical, ceramic/carbon faces, rated to minimum 225 F.

D. Gage Connections: Tappings on pump suction and discharge connections.

E. Drain and Air Vent Connections: Tappings and plugs on pump casing.

F. Motor: NEMA Standard open drip proof, single speed. Comply with requirements in Section 230513.

G. Flexible Coupling Guard: Metal, OSHA approved.

H. Structural Support: Mount pump assembly on a rigid, structural steel frame with components aligned by factory-trained erection personnel.

I. Manufacturers: Bell & Gossett 1510 Series, Armstrong Fluid Technology, Grundfos Pumps, or approved.

2.3 PUMP DISCHARGE FLEXIBLE CONNECTORS

A. Description: Factory assembly with carbon steel vane within corrugated hose with stainless steel woven wire braid between 150 psig carbon steel flanges. Include carbon steel reducing elbow for horizontal discharge pump.

B. Grooved Joint Piping Application: Same as above except system end grooved, ductile iron or steel body, rated to 300 psig WOG.

C. Manufacturer: Metraflex Vane Flex™ or approved.

2.4 VIBRATION MONITOR

A. Description: Factory furnished for field installation, device continuously measures and monitors vibration due to pump and motor bearing wear unbalance, misalignment, unacceptable pipeline forces, cavitation, water hammer, harmonic vibration, and flow rate exceeding maximum for flexible coupled pump. Include “RED” LED blinking alarm light and “GREEN” LED to indicate that monitor is operating and has sufficient battery power. Include provisions for connection for DDC system specified in Section 230900 for digital output for alarm.

B. Manufacturer: SIHIdetect Sensor, Bell & Gossett i-ALERT^{TM} Condition Monitor, or approved.

PART 3 - EXECUTION

3.1 INSPECTION

A. General: Verify installation conditions as satisfactory to receive the Work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

3.2 PREPARATION

A. Field Measurements: Field verify locations of new and existing work prior to commencing the Work of this section.

B. Protection: Protect surrounding areas and surfaces to preclude damage from the Work of this section.

3.3 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

A. General: Install, apply, erect, and perform the Work in accordance with Article “Quality Assurance” provisions, specifications, and manufacturer’s installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

3.4 INSTALLATION OF PUMPS

A. General: Support pumps and piping separately so piping is not supported by pumps.

B. Base Mounted In-Line Pump Installation: Support pump from housekeeping pad by fabricated pipe or welded steel assembly as indicated on the Drawings. Comply with requirements in Section 230510 for supports, miscellaneous steel, and attachments, Section 230548 for vibration isolators, and Section 230550 for seismic restraints.

3.5 START-UP SERVICES

A. The Contractor shall provide start-up services of the pumps. Services shall include a check of proper installation, verification that pump suction diffuser start-up strainers have been removed, system check-out, adjustment, electrical service and motor grounding, and complete start-up. Coordinate start-up services with TAB work specified in Section 230593.

B. Pump Impeller Trim: Refer to Section 230593 for impeller trim requirements to be performed by pump manufacturer or authorized representative.

3.6 HVAC SYSTEMS TRAINING

A. Comply with requirements in Section 230810.

3.7 COMMISSIONING

A. Equipment and systems referenced in this section shall be commissioned per Section 230800. The Contractor has specific responsibilities for scheduling, coordination, test development, testing and documentation.

END OF SECTION 232123

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Description: The Work includes refrigerant piping and specialties.

B. Contract Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to the Work in this section.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.

B. Codes and Standards:

1. ARI 710, Liquid-Line Driers.
2. ARI 730, Flow-Capacity Rating of Suction-Line Filters and Suction-Line Filter-Driers.
3. ARI 750, Thermostatic Refrigerant Expansion Valves.
4. ARI 760, Solenoid Valves for Use with Volatile Refrigerants.
5. ASHRAE Standard 15, Safety Code for Mechanical Refrigeration.
6. ASHRAE Standard 34, Designation and Safety Classification of Refrigerants.
7. ASME B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
8. ASME B31.5, Refrigeration Piping and Heat Transfer Components.
9. ASME BPVC, Boiler and Pressure Vessel Code, Section VIII, Division 1, Rules for Construction of Pressure Vessels.
10. ASME BPVC, Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications.
11. ASTM B 280, Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
12. AWS A5.8, Specification for Filler Metals for Brazing and Braze Welding.
13. MSS SP- 58, Pipe Hangers and Supports – Materials, Design, Manufacture, Selection, Application, and Installation.
14. MSS SP- 69, Pipe Hangers Supports – Selection and Application.
15. UL 429, Electrically Operated Valves.

C. Refrigeration Piping Subcontractor Qualifications: Company specializing in performing the work of this Section with minimum 5 years' experience.

D. Refrigeration piping subcontractor shall size piping in accordance with refrigeration equipment manufacturer's recommendations and sizing requirements.

1.3 SUBMITTALS

A. Comply with requirements in Division 01 and Section 230500.

B. Product Data: Submit manufacturer's technical product data and maintenance data for the following:

1. Refrigerant piping.
2. Refrigerant.
3. Flexible connectors.
4. Shutoff valves.
5. Check valves.
6. Sight glass with liquid indicators.
7. Filter dryers.
8. Solenoid valves.
9. Thermal expansion valves.
10. Pipe supports.
11. Blank copy of start-up and test report form.

C. Qualifications: Submit documentation as defined under Paragraph "Refrigeration Piping Subcontractor Qualifications".

D. Design Data: Basis of pipe sizing. Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.

E. Test Reports:

1. Testing and charging reports for each system.
2. Field start-up and test reports.
3. Include completed copy of reports in the Operations and Maintenance Manual.

PART 2 - PRODUCTS

2.1 REFRIGERANT PIPING

A. Pipe: Copper, Type ACR hard drawn, ASTM B 280, cleaned and dehydrated for refrigeration service with ends capped and sealed, 300 psig working pressure rating.

B. Fittings: Wrought copper solder joint, ASME B16.22.

C. Joints: Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy with melting range 1190 F to 1480 F.

2.2 REFRIGERANT

A. Description: Comply with ASHRAE Standard 34. Type as indicated on the Drawings.

2.3 FLEXIBLE CONNECTORS

A. Description: Corrugated stainless steel hose with single layer of stainless steel exterior braiding, minimum 9 inch long with copper tube ends. Maximum working pressure 500 psig.

B. Manufacturers: Superior Valve Company, Parker Hannifin Corporation, Packless Industries, Anaconda Universal Associates, Inc., or approved.

2.4 SHUTOFF VALVES

A. Diaphragm Packless Valves: UL listed and labeled, globe design with straight-through or angle pattern, forged brass body and bonnet, phosphor bronze and stainless steel diaphragms, rising stem and handwheel, stainless steel spring, nylon seat disc, solder or flared ends, with positive backseating. Maximum working pressure 500 psig and maximum temperature 275 F.

B. Packed Angle Valves: Forged brass construction, forged brass seal caps with copper gasket, rising stem and seat with backseating, molded stem packing, solder or flared ends. Maximum working pressure 500 psig and maximum temperature 275 F.

C. Ball Valves: Two piece bolted forged brass body with Teflon® ball seals and copper tube extensions, brass bonnet and seal cap, chrome plated ball, stem with neoprene ring stem seals. Maximum working pressure 500 psig and maximum temperature 300 F.

D. Service Valves: Forged brass body with copper stubs, brass caps, removable valve core, integral replaceable ball check valve, flared or solder ends. Maximum pressure 500 psig.

E. Manufacturers: Superior Valve Company, Parker Hannifin Corporation, Henry Technologies, or approved.

2.5 CHECK VALVES

A. Description: Cast bronze valve body, globe style, forged brass bolted bonnet, solder ends, and Teflon® seat. Internal parts removeable. UL listed and labeled. Maximum working pressure 500 psig and temperature range of minus 20 F to 300 F. Bi-directional for heat pump applications.

B. Manufacturers: Henry Technologies or approved.

2.6 SIGHT GLASS WITH LIQUID INDICATORS

A. Description: Double port type, UL listed and labeled, copper or brass body, flared or solder ends, sight glass, color coded paper moisture indicator with removable element cartridge and plastic cap. Maximum working pressure 430 psig, and maximum temperature of 200 F.

B. Manufacturers: Sporlan Valve Company, Parker Hannifin Corporation, Alco Controls, Mueller Industries, or approved.

2.7 FILTER DRYERS

A. Permanent Straight Through Type:

1. Description: ARI 710 listed and labeled, steel shell with molded desiccant filter core, for maximum working pressure of 500 psig.

2. Rating: ARI 730 flow capacity for scheduled tons.

B. Manufacturers: Sporlan Valve Company, Parker Hannifin Corporation, Alco Controls, or approved.

2.8 SOLENOID VALVES

A. Valve: ARI 760, pilot operated, copper or brass body and internal parts, synthetic seat, stainless steel stem and plunger assembly, integral strainer, with flared, solder, or threaded ends. Maximum working pressure 400 psig. Stem shall permit manual operation in case of coil failure.

B. Coil Assembly: UL 429 listed and labeled, replaceable with molded electromagnetic coil, moisture and fungus proof, surge protector and color coded lead wires, integral junction box.

C. Manufacturers: Sporlan Valve Company, Parker Hannifin Corporation, Alco Controls, or approved.

2.9 THERMAL EXPANSION VALVES

A. Description: ARI 750, angle or straight through type, design suitable for refrigerant, brass body, internal or external equalizer, bleed hole, mechanical pressure limit (maximum operating pressure feature), adjustable superheat setting, replaceable inlet strainer, non-replaceable capillary tube and remote sensing bulb.

B. Selection: Evaluate refrigerant pressure drop through system to determine available pressure drop across valve. Select valve for maximum load at design operating pressure and minimum 10 F superheat. Select to avoid being undersized at full load and excessively oversized at part load.

C. Manufacturers: Sporlan Valve Company, Parker Hannifin Corporation, Alco Controls, Henry Technologies, or approved.

2.10 PIPE SUPPORTS

A. Comply with requirements in Section 232116. In addition, furnish insulated pipe clamps, National Refrigeration Products (NRP) Insulclamps, Hydra-Zorb® Klo-Shure Insulation Couplings, Hydra-Zorb® Cushion Clamp Assemblies, Hydra-Zorb® Titan® Insulation Riser Clamp Series, Hydra-Zorb® Bronco® Support for Insulated Pipes, or approved.

PART 3 - EXECUTION

3.1 INSPECTION

A. General: Verify installation conditions as satisfactory to receive the Work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

3.2 PREPARATION

A. Field Measurements: Field verify locations of new and existing work prior to commencing the Work of this section.

B. Protection: Protect surrounding areas and surfaces to preclude damage from the Work of this section.

3.3 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

A. General: Install, apply, erect, and perform the Work in accordance with Article “Quality Assurance” provisions, specifications, and manufacturer’s installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

B. Do not cover up or enclose work until inspected and approved. If in non-compliance, uncover work, remove, and provide new to satisfaction of the A/E at no additional cost to the Owner.

3.4 MECHANICAL EQUIPMENT CONNECTION

A. Connect refrigerant piping to mechanical equipment as indicated on the Drawings. Comply with equipment manufacturer’s installation instructions.

3.5 PIPING INSTALLATION

A. Install pipe supports in accordance with MSS SP-58, MSS SP-69, and Section 232116, whichever is more stringent.

B. Installation:

1. Ream pipe and tube ends. Remove burrs.
2. Take care to keep piping clean and dry. Wet tubing not acceptable.
3. Remove scale and dirt on inside and outside before assembly.
4. Prepare piping connections to equipment with flanges, unions, or flared connections.
5. Install piping to prevent liquid refrigerant from entering compressor. Slope horizontal suction piping toward compressor. Slope horizontal hot gas discharge piping downward away from compressor.
6. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment and to prevent compressor piping vibration being transmitted to building construction.
7. Provide clearance for installation of insulation and access to valves and fittings.
8. Flood piping system with nitrogen when brazing.
9. Install refrigeration specialties factory furnished with equipment specified in Section 238100.

C. Oil Return:

1. Arrange piping to return oil to compressor.
2. Install traps, loops, and double risers in piping as required by refrigeration equipment manufacturer.

3. Slope horizontal piping at 0.40 percent in direction of flow.

D. Flexible Connectors: Install at connections to air conditioning units, condensing units and fan coil units specified in Section 238100.**]**

E. Filter Dryers: Install replaceable cartridge angle type with a 3-valve bypass arrangement.

F. Thermal Expansion Valves:

1. Locate expansion valve sensing bulb immediately downstream of evaporator on suction line.
2. Provide external equalizer piping for expansion valves furnished with such connections.

G. Electrical: Provide electrical connections where not indicated on Div 26 drawings. Coordinate with Section 230900 and Division 26.

3.6 TESTING AND CHARGING

A. Testing:

1. Test refrigeration system in accordance with ASME B31.5.
2. Pressure test system with dry nitrogen to 250 psig.
3. Perform final tests at 27 inch vacuum and 375 psig using halide torch or electronic leak detector.
4. Test to no leakage. If leakage occurs, repair and retest until leakage is zero.

B. Evacuating and Charging:

1. Install cartridge in replaceable cartridge type filter dryers after leak test but before evacuation.
2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
4. Perform evacuation in the presence of the Owner’s representative. Notify Owner’s Representative at least 72 hours before expected test.
5. Fully charge completed system with refrigerant after testing.
6. Follow ASHRAE Standard 15 procedures for charging and purging of systems and for disposal of refrigerant.

3.7 HVAC SYSTEMS TRAINING

A. Comply with requirements in Section 230810.

3.8 COMMISSIONING

A. Equipment and systems referenced in this section shall be commissioned per Section 230800. The Contractor has specific responsibilities for scheduling, coordination, test development, testing and documentation.

END OF SECTION 232300

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Description: The Work includes chemical cleaning and chemical water treatment for heating water and chilled water piping systems. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to the Work in this section.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.

B. Codes and Standards:

1. ASME B31.1, Power Piping.
2. ASTM D 1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Components.
3. Local environmental regulations.

C. Treatment Specialist Qualifications:

1. Local representative with minimum 5 years' experience in chemical cleaning and chemical treatment of piping systems for projects of similar size to this project. Company in the business of selling chemicals and equipment for chemical flushing and chemical treatment of piping systems for at least 5 years with staff for technical services and on-site consulting and trouble-shooting capabilities.
2. Water treatment company shall have, as a part of its direct organization or at its disposal, recognized water treatment research and analytical laboratory with capability of analyzing and interpreting water, deposit, biological and metallographic samples.

1.3 SUBMITTALS

A. Comply with requirements in Division 01 and Section 230500.

B. Product Data: Submit manufacturer's technical product data and maintenance data for each chemical and appurtenance as follows. Include MSDS sheets for each chemical used for water treatment chemicals and chemical treatment equipment.

1. Chemical treatment.
2. Chemical pot feeder for closed systems.
3. MSDS sheets.
4. Blank copy start-up and test report form.

C. Certifications: Treatment specialist qualifications.

D. Test Reports:

1. Water analysis.
2. Chemical cleaning and chemical treatment operations.
3. Field start-up and test reports.
4. Submit completed copy of reports and include copy in the Operations and Maintenance Manual.

1.4 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Section 232113 – Hydronic Piping Systems: Water treatment equipment and associated components.

PART 2 - PRODUCTS

2.1 CHEMICAL TREATMENT

A. Description: Chemical cleaning of heating water and chilled water piping after initial flushing and pressure testing have been performed per requirements in Section 232113. Work also includes chemical treatment following cleaning of piping. Work performed under supervision of water treatment specialist. Estimated hydronic system volumes are:

1. Heating Water: 4,100 gallons.
2. Chilled Water: 2,200 gallons.

B. Water Analysis: Perform water analysis for locally available water. Make recommendations as to required chemicals and quantities based on water analysis. Include copy in the Operations and Maintenance Manual.

C. Chemicals:

D. Chemicals:

1. Standards: Chemical treatment in accordance with currently accepted standards for the Environmental Protection Agency (EPA). Chemicals EPA registered and labeled in accordance with EPA Standards. Comply with local codes, statutes, and requirements for addition of non-potable chemicals to building systems and for discharge to public sewers.
2. Chemical Cleaning of Piping: Biodegradable, equal to HydroChem 280 for flushing with hot water and HydroChem 281 for flushing with cold water to remove pipe protective coatings and oil.
3. Chemicals for Boiler Boilout: Chemicals one of the following:

a. 0.05 percent by weight sodium hydroxide.
b. 0.09 percent by weight potassium hydroxide.
c. 0.1 percent by weight trisodium phosphate.
d. Water treatment specialist’s cleaning solution as blend of hydroxides, passivators, and surfactants.

4. HVAC Equipment with Condensate Drain Pans: EPA registered biocide tablet in sealed tamper-proof housing to control slime buildup, bacterial growth and musty odors.

E. Test Kit: Necessary reagents and supplies packed inside a high-impact plastic carrying case with directions for the following:

1. Corrosion and scale inhibitor formulation and conductivity for closed systems.

F. Manufacturers: U.S. Water Services, Inc.. No substitutions.

2.2 CHEMICAL POT FEEDER FOR CLOSED SYSTEMS

A. Description: Vessel designed to facilitate feeding chemicals into and chilled water systems for water treatment.

B. Construction: Welded steel to ASME standards, minimum 125 psig working pressure, connections including inlet, outlet, drain valve, and petcock vent. Quick opening cap for loading chemicals. Include pleated 20 micron filter.

C. Capacity: Ten gallons.

D. Sight Glass: Bronze construction with screwed ends, ball action, and tempered glass window rated for 200 psig. Ernst Flow Industries Model EF1 E-57-4 or approved.

E. Manufacturers: J.L. Wingert Company, Neptune Chemical Pump Company, or approved.

PART 3 - EXECUTION

3.1 INSPECTION

A. Description: Verify installation conditions as satisfactory to receive the Work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

3.2 PREPARATION

A. Field Measurements: Field verify locations of new and existing work prior to commencing work of this section.

B. Protection: Protect surrounding areas and surfaces to preclude damage from the Work of this section.

3.3 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

A. Description: Install, apply, erect, and perform the work in accordance with Article “Quality Assurance” provisions, specifications, and manufacturer’s installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

3.4 WATER ANALYSIS

A. Perform water analysis to determine quality of water available.

3.5 CHEMICAL TREATMENT

A. Chemical Cleaning of Piping:

1. Following initial flushing as specified in Section 232113, chemically clean designated piping systems with flushing agent solution to remove pipe protective coatings and oil.
2. Coordinate with mechanical subcontractor and controls system subcontractor for their assistance and be responsible to have manual and automatic control valves fully open.
3. Measure system volume with water meter, when filling, and record volume. Use this value to determine amount of flushing agent to use. Install separate water meters in make-up water pipes to HVAC systems specified in Sections 232113 and 232200. Provide flushing agent quantity in solution in accordance with manufacturer's recommendations.
4. Heat cleaning solution to minimum 180 F. If project does not include a heating source to heat cleaning solution to minimum 180 F, provide temporary heat source and its required utilities.
5. Circulate mixture for 18 hours at 180 F.
6. Drain system and flush with water until water is clear, conductivity is within 50 micromhos/cm of makeup water, and has pH no greater than 8.3. Dispose of effluent in manner acceptable to the AHJ.
7. Clean and flush traps and strainer screens of debris and foreign matter.
8. Extent: Within 2 hours of completing chemical flushing, install chemical treatment for heating water. Recommend proper treatment for systems and initiate various treatments, including required chemicals.

B. Existing System Extension – Boiler Plant:

1. Install chemical treatment for new piping added to existing heating water system based on volume of water in new piping added. Use existing equipment and method of adding chemicals.
2. Recommend proper treatment for systems and initiate various treatments, including required chemicals. Chemicals used shall be same as the chemicals currently being used in existing systems.
3. Estimated hydronic system volumes are:

C. HVAC Equipment with Condensate Drain Pans: Install tablets in integral and auxiliary drain pans when equipment is initially put into operation. Install additional tablets half way through and just prior to expiration of warranty period.

D. Reports: Prepare reports of chemical cleaning of piping and chemical treatment operations and submit to the A/E.

E. Install test kit on wall near water chemical application equipment or at location as directed by the Owner.

3.6 START-UP SERVICES

A. Equipment manufacturer's authorized representative shall perform start-up services of non-chemical water treatment system and related appurtenances. Services shall include check of proper installation of field assembled components, system check-out, adjustment, and complete start-up. Start-up by Contractor not acceptable.

B. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, filled with water, and are fully operational.

C. Coordinate start-up services with heating water and chilled water piping system operation as specified in Division 01 and Section 230500 and TAB work specified in Section 230593.

3.7 POST INSTALLATION SERVICES

A. System Assurance: Maintain system at proper chemical level until final completion. Following final completion, furnish chemicals for 1 year's required supply of water treatment delivered as directed by the Owner in sealed containers for each system. Coordinate with the Owner as to whether required supply of chemicals is delivered at 1 time or at specific intervals during the 1 year period.

B. Hydronic Systems Service Calls:

1. Make 2 field service calls during first month of operation for each system followed by monthly field service calls until final acceptance.
2. Following each service call, forward written report of the field test results and any changes or adjustments to the A/E and the Owner. In addition, draw samples of treated water and send to laboratory for reference testing. Forward copies of results to the A/E and the Owner.

C. End of Warranty Inspection: Arrange with the Owner for inspection of internal surfaces of chiller tubes and similar equipment prior to end of warranty period. Based on results of these inspections, make recommendations as to adjustments to water treatment procedures.

D. System Labeling: Upon completion of chemical flushing and chemical treatment, label each system same as for identification of piping specified in Section 200510 as follows: "THIS SYSTEM HAS BEEN CLEANED AND CHEMICALLY TREATED. DO NOT DISTURB UNLESS AUTHORIZED". Locate labels to be plainly visible.

E. Report: Prepare reports of cleaning and chemical treatment operations and submit copies to the A/E.

3.8 HVAC SYSTEMS TRAINING

A. Comply with requirements in Section 230810.

3.9 COMMISSIONING

A. Equipment and systems referenced in this section shall be commissioned per Section 230800. The Contractor has specific responsibilities for scheduling, coordination, test development, testing and documentation.

END OF SECTION 232500

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Description: The Work includes sheet metal work and associated appurtenances.

B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to the Work in this section.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.

B. Codes and Standards:

1. ASTM A 480, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
2. ASTM A 653, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
3. ASTM A 1008, Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength, Low-Alloy, High-Strength, Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
4. ASTM B 209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
5. ASTM C 177, Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
6. ASTM C 411, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
7. ASTM C 423, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
8. ASTM C 518, Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
9. ASTM C 916, Standard Specification for Adhesives for Duct Thermal Insulation.
10. ASTM C 1071, Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
11. ASTM C 1338, Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings.
12. ASTM C 1524, Standard Test Method for Water-Extractable Chloride in Aggregate (Soxhlet Method).
13. ASTM C 1534, Standard Specification for Flexible Polymeric Foam Sheet Insulation Used as a Thermal and Sound Absorbing Liner for Duct Systems.
14. ASTM D 1622, Standard Test Method for Apparent Density of Rigid Cellular Plastics.
15. ASTM D 1667, Standard Specification for Flexible Cellular Materials-Vinyl Chloride Polymers and Copolymers (Closed-Cell Foam).
16. ASTM D 2412, Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.
17. ASTM D 3574, Standard Test Methods for Flexible Cellular Materials-Slab, Bonded, and Molded Urethane Foams.

18. ASTM E 84, Standard Test Method for Surface Burning Characteristics of Building Materials.
19. ASTM E 90, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
20. ASTM G 21, Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
21. NAIMA Duct Liner Installation Standards.
22. NFPA 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems.
23. NFPA 90B, Standard for the Installation of Warm Air Heating and Air--Conditioning Systems.
24. SMACNA HVAC Air Duct Leakage Test Manual, (SMACNA Leakage).
25. SMACNA HVAC Duct Construction Standards, Metal and Flexible (SMACNA).
26. SMACNA Rectangular Industrial Construction Standards, (SMACNA Rectangular).
27. SMACNA Round Industrial Construction Standards, (SMACNA Round).
28. UL 181, Standard for Factory-Made Air Ducts and Air Connectors.
29. UL 181B, Standard for Closure System for Use with Flexible Air Ducts and Air Connectors.
30. UL 723, Standard for Test for Surface Burning Characteristics of Building Materials.

C. Duct Cleanliness Requirements:

1. Prevent damage to ducts during transportation and off-loading. Deliver only when ducts can be stored under permanent cover. Plastic tarp covering of ducts on jobsite not acceptable.
2. Keep site storage areas clean and dry with minimal exposure to dust.
3. Keep working area clean and dry and protected from weather elements.
4. Prior to installation of individual duct sections, inspect to ensure they are free from debris and wipe internal metal surfaces.
5. Cover duct risers to prevent entry of debris.
6. Cover open ends of ducts and downward facing and horizontal duct openings.
7. If, in the opinion of the A/E, ducts and fittings are not kept clean or completely dry, replace ducts and fittings or clean interior of affected ducts and fittings to satisfaction of the A/E at no additional cost to the Owner.

1.3 SUBMITTALS

A. Comply with requirements in Division 01 and Section 230500.

B. Product Data: Submit manufacturer’s technical product data and maintenance data for the following:

1. Sheet metal work, general.
2. Sheet metal work, miscellaneous.
3. Four-bolt or corner-clip duct connection system.
4. Factory soundlined ducts, round.
5. Factory soundlined ducts, rectangular.
6. Flexible ducts.
7. Duct soundlining, fiberglass.
8. Duct soundlining, non-fiberglass.
9. Fasteners.
10. Hangers for sheet metal work.

11. Duct supports on roof.
12. Drain pans.
13. Miscellaneous duct accessories.
14. Blank copy of start-up test and report form.

C. Shop Drawings: Comply with requirements in Section 230500.

D. Test Reports:

1. Test apparatus calibration certificate for duct leakage testing.
2. Pressure testing for leakage.
3. Type I hood duct leakage tests.
4. Submit completed copy of reports and include copy in the Operations and Maintenance Manual.

E. Manufacturer's Certificate: Certify that phenolic foam pre-insulated duct installation meets or exceeds specified requirements including certified training of fabricator and installer.

F. Manufacturer's Test Report: Certified test data on transmission loss and sound absorption characteristics for factory fabricated plenum walls.

1.4 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION

A. Section 230548 – Vibration Isolation: Flexible connectors.

B. Section 283111 – Fire Alarm and Detection Systems: Duct smoke detectors.

PART 2 - PRODUCTS

2.1 SHEET METAL WORK, GENERAL

A. Duct Construction:

1. Comply with SMACNA. Standing seams not acceptable for exposed ducts.
2. Galvanized steel in general with G-90 zinc coating, ASTM A 653, minimum 26 gage.
3. Galvanized steel prepped or ducts finished with Paint Grip for field painting where exposed in finished spaces as scheduled in Division 09.

B. Pressure Classifications:

1. Ducts between Variable Air Volume (VAV) Air Handling Units and VAV and Fan Powered Terminal Units: 6 inch w.g.
2. Ducts downstream of VAV and Fan Powered Terminal Units: 2 inch w.g.
3. Return and Exhaust Ducts: Plus 2 inch downstream of fans and minus 2 inch w.g. upstream of fans for fan design static pressure scheduled on the Drawings at 1.0 inch w.g. and above.
4. Return, Relief, and Exhaust Ducts: Plus 1 inch downstream of fans and minus 1 inch w.g. upstream of fans for fan design static pressure scheduled on the Drawings at less than 1.0 inch w.g. Plus 1 inch w.g. for relief ducts.

5. Outside Air Ducts: Minus 2 inch w.g.
6. Supply Ducts not Listed Above: 2 inch w.g.
7. Transfer Ducts: 0.5 inch w.g.

C. Round and Flat Oval Ducts: Spiral seam with beaded sleeve at transverse joints for round ducts less than 34 inch diameter and flat oval ducts with minor dimension less than 24 inch and major dimension less than 42 inch.

D. Fittings:

1. Comply with SMACNA as follows:

   a. Round and Flat Oval Elbows: Full radius (R/D=1.5), spiral seam for 6 inch w.g. ducts and 5 piece segmented or stamped for 2 inch w.g. ducts. Adjustable elbows not acceptable.
   b. Rectangular Elbows: Full radius (R/W=1.5) where minimum 5 duct widths is available downstream of elbow fitting prior to branch take off. If straight length not available, use square throat elbow with turning vanes.
   c. Round and Flat Oval Tees and Laterals: Conical fitting or tap per SMACNA Figure 3-6, 90 degree tee with oval to round tap, 45 degree lateral fitting, tap, or saddle tap, or 45 degree rectangular lead-in per SMACNA Figure 3-5. 90 degree tee not acceptable. Saddle tap connections for exposed ducts in finished spaces not acceptable.
   d. Spin-in Fittings: Conical type, with volume damper, quadrant, and accessories for 2 inch w.g. ducts. Include closed outside end bearing, insulation guard for installation in duct with soundlining, and standoff bracket for installation in duct with insulation.
   e. Rectangular Laterals: 45 degree entry fittings per SMACNA Figure 4-6.
   f. Offsets: Full radius (R/D=1.5 for round and flat oval and R/W=1.5 for rectangular) where space allows. Mitered offset (Type 2) with 30 degree maximum offset angle per SMACNA Figure 4-7. Angle offset (Type 1) not acceptable.
   g. Divided flow fittings acceptable per SMACNA Figure 4-5 for rectangular ducts except for branch connections to outlets and inlets.

2. Bellmouth Fittings: 18 gage spun sheet metal, formed into uniform radius bellmouth. Minimum radius of bell equal to 0.2 times neck diameter.
3. Screened Openings: 1/2 inch mesh screen, 14 gage galvanized steel wire. Enclose mesh screen with 20 gage galvanized removable sheet metal frame around perimeter.
4. Duct Collars: 2 inch wide galvanized steel for galvanized ducts, 20 gage. Mitered corners for square and rectangular ducts. Escutcheon type for round and flat oval ducts.

E. Turning Vanes:

1. Description: Airfoil design, smoothly-rounded entry nose, extended trailing edge, continuous internal tubes for stiffening and rigidity of section, adaptable to duct sizes. Maximum generated sound power level 54 decibels in octave band 4 at 2000 fpm velocity in 24 inch by 24 inch duct size.
2. Assembly Fabrication: Side rails by same manufacturer as turning vanes. Vanes installed on 2.4 inch centers across full diagonal dimension of elbow per SMACNA Figure 4-3. Rail systems with non-standard tab spacing not acceptable.
3. Unequal Elbows: Fabricate and adjust to set vanes in assembly at correct angle of attack, resulting in leading and trailing edges in parallel to duct surfaces.

4. Manufacturer: H.E.P. - High Efficiency Profile - as manufactured by Aero Dyne Co. (1-800-522-2423) or approved.
5. At Contractor's option, double wall turning vanes fabricated from same material as adjacent duct acceptable. Include mounting rails with friction insert tabs that align vanes automatically.

F. Acoustical Turning Vanes:

1. Double wall, perforated, glass fiber fill, polyester liner.
2. Manufacturer: Ductmate Industries Inc. or approved.

G. Soundlined Ducts: Fabricate with duct soundlining such that no gap will result between sections of duct lining after assembly of duct sections. Fabrication and installation shall result in adjacent soundlining sections butted together without gaps, bulges, or other discontinuities.

H. Duct Sealant, Traditional Method (Contractor Option)

1. Indoor Locations: UL 181 listed and labeled. Low odor, non-toxic vapors, surface burning characteristics for maximum flame spread of 25 and maximum smoke developed of 50 when in a dry state. Rated for air temperature range of minus 20 F to plus 150 F. Rated to 10 inch w.g., minimum 65 percent solid content. Foster® 32-19™ Duct-Fas, Childers CP-146 Chil-Flex™, McGill AirSeal LLC, United Duct Sealer™ (Water Based), Biddle Aqua-Crylic HVAC, Hardcast Iron-Grip 601, Design Polymerics DP1010, Ductmate Industries Inc. PROseal^{EZ} or EZseal™, or approved.
2. Outdoor Locations: UL 181 listed and labeled. 3 inch minimum width. Surface burning characteristics of 25 maximum flame spread and 50 maximum smoke developed. Rated for air temperature range of minus 40 F to plus 200 F. Sealer with UV inhibitors. Foster® 32-19™ Duct-Fas, Childers CP-146 Chil-Flex™, McGill AirSeal LLC Uni-Mastic™ 181 Duct Sealer , Ductmate Industries Inc. PROseal, or approved.

2.2 FOUR-BOLT OR CORNER-CLIP DUCT CONNECTION SYSTEM

A. General: System used for rectangular sheet metal work at Contractor's option.

B. Components: Roll-formed 20 gage galvanized steel flanges with integral mastic sealer, embossed corner pieces, UL listed and labeled, metal cleats, duct sealer, closed cell neoprene gaskets, and cadmium plated bolts and nuts.

C. Lined Ducts: Fabricate with no gaps, bulges, or other discontinuities between adjacent sections of duct lining after assembly.

D. Manufacturers: Ductmate Industries Inc, Nexus™, Ward Industries, or approved. Fabricate in strict conformance to manufacturer's instruction.

2.3 FACTORY SOUNDLINED DUCTS, ROUND AND FLAT OVAL

A. Description: Double-walled, internally insulated, duct system components.

B. Construction:

1. Outer Pressure Shell Ducts and Fittings: Spiral wound, galvanized steel, gages to meet or exceed SMACNA for pressure classification specified in this section:
2. Inner Liner, Ducts: Perforated galvanized steel, gages as follows:

    a. Ducts 3 inch to 8-1/2 inch Diameter: 28 gage.
    b. Ducts 9 inch to 42 inch Diameter: 28 gage.
    c. Ducts 44 inch to 60 inch Diameter: 26 gage.
    d. Ducts 62 inch to 84 inch Diameter: 22 gage.

3. Inner Liner, Fittings: Perforated galvanized steel, gages as follows:

    a. Ducts 3 inch to 34 inch Diameter: 24 gage.
    b. Ducts 35 inch to 58 inch Diameter: 22 gage.
    c. Ducts 60 inch to 84 inch Diameter: 20 gage.
    d. Perforations with overall open area not less than 23 percent.

4. Insulation: 2 inch thick, 1 PCF density, K-value 0.27 Btu/hr/sq ft/F at 75 F mean temperature, UL listed and labeled for maximum flame spread of 25 and maximum smoke developed of 50.
5. Concentricity: Mechanical fastening to maintain positive concentricity of liner with shell.
6. Insulation Attachment: Mechanical fastening to retain insulation against dislocation by assembly processes.
7. Duct Connections: Slip joint. McGill AirFlow LLC, Uni-Flange™ or Ductmate Industries Spiramate acceptable for concealed installations.
8. Adapters: Include insulation ends for terminations of soundlined duct runs.
9. Divided Flow Fittings: Construct with radiused entrance to branch top with solid welded connection.

C. Manufacturer: McGill AirFlow LLC, Acousti-k27® or approved.

2.4 FACTORY SOUNDLINED DUCTS, RECTANGULAR

A. Description: Double-walled, internally insulated, duct system components.

B. Construction:

1. Outer Shell: Galvanized steel, 24 gage.
2. Inner Liner: Perforated galvanized steel, 20. Perforations with overall open area not less than 23 percent.
3. Insulation: 2 inch thick, 1.55 PCF density, K-value 0.27 Btu/hr/sq ft/F at 75 F mean temperature, UL listed and labeled for maximum flame spread of 25 and maximum smoke developed of 50.
4. Duct Connections: Lockformer TDC System.

C. Manufacturer: McGill AirFlow LLC, Rectangular-k27® or approved.

2.5 FLEXIBLE DUCTS

A. Description: Factory-insulated with low permeability vapor barrier jacket constructed of reinforced metalized laminate film, suitable for medium and low pressure applications, 1 inch

thick fiber glass insulation, coated steel spring helix reinforcement bonded to chlorinated polyethylene liner.

1. Ratings: UL 181 listed and labeled as a Class 1 flexible duct with maximum flame spread rating 25, maximum smoke-developed rating 50.
2. Length: Assemblies in 5 foot length with galvanized male and female fittings attached to liner and vapor barrier jacket acceptable.

B. Manufacturers: Thermaflex[flex] MK-E, Wiremold 57K, Flexmaster U.S.A.® 8m, or approved.

2.6 DUCT SOUNDLINING, FIBERGLASS

A. Description: Fiberglass acoustical and thermal insulation, 1 inch thick unless noted otherwise on the Drawings.

B. Standards and Ratings: ASTM C 1071 Type I (flexible) and Type II (rigid), and NFPA 90A, for preformed duct liners. K-value 0.24 Btu/hr/sq ft/F at 75 F mean temperature per ASTM C 177.

C. Composition:

1. Semi-rigid borosilicate fibers bonded in thermosetting resin.
2. Density 1-1/2 lb. per cu. ft.
3. R-value 4.2 hr/sq ft/F/Btu per ASTM C 518.
4. Composite surface burning characteristics for maximum flame spread of 25 and maximum smoke developed of 50 per ASTM E 84, NFPA 255, and UL 723.
5. Temperature limit 250 F.
6. Velocity rated at 6000 fpm.
7. Airstream surface protected with acrylic coating with EPA-registered anti-microbial agent per ASTM G 21 and ASTM C 1338.
8. Factory applied edge coating with Johns Manville SuperSeal® Duct Butter, SuperSeal® Edge Treatment, or SuperSeal® HV, Childers CP-135-2 Chil Spred™ (black), or Foster 81-42W Lagfas® (white).

D. Duct Soundlining Adhesive: UL listed and labeled, surface burning characteristics for maximum flame spread of 25 and maximum smoke developed of 50. Water based and non-flammable in wet or dry state. ASTM C 916 Type II. McGill AirSeal LLC Uni-Tack, Hardcast Glas-Grip 658, Design Polymerics DP5050, Foster® 85-65™, Childers CP-127 Chil-Quik, or approved.

E. Manufacturers:

1. Rectangular Duct: Johns Manville Linacoustic® RC, Knauf EM, Certainteed ToughGuard® R, Manson Insulation AKOUSTI-LINER™, or approved.
2. Rectangular Plenums: Johns Manville Linacoustic® R-300 rigid plenum liner board, Knauf Rigid Plenum Liner, Certainteed ToughGuard® Rigid Liner Board, Manson Insulation AKOUSTI-LINER R™, or approved.
3. Round Duct: Johns Manville Spiracoustic Plus™ preformed self-supporting “slide-in” duct liner or approved.

2.7 FASTENERS

A. Description: Use blind rivets, sheet metal screws, or bolted connections where required by SMACNA for attachment purposes for sheet metal. Sheet metal screws and rivets minimum length required for secure fastening. Where rivets are specifically called for in this section, sheet metal screws may be used.

B. Locations: For ducts, grilles, and accessories exposed to view in finished rooms, include finish-type fasteners.

1. Permanent Work: Blind stainless steel pop rivets.
2. Removable Items and Grilles: Cadmium-plated pan head or countersunk tapping screws.

2.8 HANGERS FOR SHEET METAL WORK

A. Description: Hangers, supports, and anchor bolts for sheet metal work and equipment, same material as for duct construction.

B. Building Attachments: Concrete inserts and structural-steel fasteners appropriate for construction materials to which hangers are being attached. Comply with requirements in Section 230510.

C. Duct Sizes: Refer to maximum cross-section dimension at location of hangers.

D. Horizontal Rectangular and, Round Ducts: Comply with SMACNA. Wire hangers not acceptable.

E. Ducts: Adjustable cable hanging system tested and certified to comply with SMACNA for upper and lower attachment methods. System consists of matching components including steel cables, spring loaded, serrated clamping mechanism, and miscellaneous hardware selected for its corresponding load rating. Ductmate Industries Inc. Clutcher Cable Hanging System, Gripple Hang-Fast Duct Hanging System, or approved.**]**

F. Vertical Ducts: Angles attached to sides in pairs. Comply with SMACNA. In shafts, include supplementary steel angles, formed steel channels, or saddles at each floor to distribute loads from bracing angles, channels, or saddles to the structure.

2.9 MISCELLANEOUS DUCT ACCESSORIES

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

PART 3 - EXECUTION

3.1 INSPECTION

A. Description: Verify installation conditions as satisfactory to receive the Work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

3.2 PREPARATION

A. Field Measurements: Field verify locations of new and existing work prior to commencing the Work of this section.

B. Protection: Protect surrounding areas and surfaces to preclude damage from the Work of this section.

3.3 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

A. General: Install, apply, erect, and perform the Work in accordance with Article “Quality Assurance”, provisions, specifications, and manufacturer’s installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

B. Do not cover up or enclose work until inspected and approved. If in non-compliance, uncover work, remove, and provide new to satisfaction of the A/E at no additional cost to the Owner.

3.4 DUCT INSTALLATION

A. General:

1. Install in workmanlike manner. Fabrications, fittings, joints, take-offs, attachments, turning vanes, dampers, and sealing in accordance with requirements of SMACNA as specified in this section and as indicated on the Drawings. If used as part of duct fabrication process, install duct labels on outside of ductwork. Installation of duct labels on inside of duct not acceptable.
2. Comply with requirements in Section 230548 for seismic restraints of ducts and for penetrations through mechanical room walls and floors and acoustical walls.
3. Hang ducts from roof structure and not from the roof deck itself. Provide formed steel channels or supplementary steel framing as specified in Section 230510 to span between roof structural members.
4. Locate ducts with sufficient clearance around equipment to allow for inspection, repair, replacement, and service.
5. Cap incomplete duct ends with temporary closures of taped polyethylene to prevent construction dust from entering ducts.
6. Install duct collars where exposed ducts pass through non-fire rated walls and ceilings. Fasten tight to ducts.
7. Duct sizes may be changed as long as the new dimensions are equivalent to those indicated and do not exceed 4 to 1 aspect ratio.
8. Transitions:

a. Fabricate and install duct transitions for connections to equipment, such as fans, coils, fire dampers, smoke dampers, combination fire/smoke dampers, motor operated dampers, VAV units and FTUs where the connection sizes are different from duct sizes indicated on the Drawings.
b. Where transitions are required to fit into available space, fabricate to maintain equivalent free area of duct sizes with angle less than 15 degrees.

9. Drawings do not show offsets which may be required. Make offsets with fittings with as small an angle of offset as possible. Install turning vanes in square corner elbows.
10. Install acoustical turning vanes in return air square throat elbows.
11. Install flanged connections to equipment with neoprene gaskets.
12. Install ducts through roof to be watertight. Coordinate with any details on the Drawings as to flashings and curbs.
13. Install straight sheet metal duct at inlet VAV units and FTUs, 2 foot or 3 equivalent duct diameters long, whichever is longer, size equal to unit inlet connection. Include transition at upstream end of straight duct if primary duct size is larger than unit inlet connection.
14. Install straight sheet metal duct at outlet of VAV units and FTUs, size to match unit outlet connection or minimum size per schedule on the Drawings with transition from outlet connection size. Install branch connections minimum 4 foot from unit outlet.
15. Install ducts within shafts without contact with walls.
16. Install ducts, unless otherwise indicated on the Drawings, vertically and horizontally and parallel and perpendicular to building lines.
17. Install test holes at fan inlets and outlets and elsewhere as indicated on the Drawings. Locate where required for testing and balancing purposes as directed by the TAB subcontractor specified in Section 230593.
18. Install return air and transfer air openings above ceilings with minimum 2’ - 0” clearance to obstructions.
19. Where existing louvers are shown on the Drawings to be blanked off, cover backside of unused portion of louver with galvanized sheet metal and caulk weathertight. Paint outside surface of blank off material flat black prior to installation.

B. Flexible Connectors:

1. Install flexible connectors furnished under Section 230548 at connections to vibration-isolated (spring and rubber isolator-mounted) fans, packaged HVAC equipment, externally isolated air handling units, fan coil units, and similar equipment. Internally isolated equipment does not require flexible connectors.
2. Support duct on both sides of flexible connector to ensure alignment and to avoid binding connector.
3. Install with sufficient slack to permit 2 inch horizontal or vertical movement without stretching fabric and to efficiently isolate vibration of fans from ducts.
4. Install flexible connector prior to fire damper, combination fire/smoke damper on mechanical room side of fire-rated wall.
5. Install equipment without flexible connectors in corridor ceiling spaces where fire rating is required.

C. Duct and Plenum Sealing, Traditional Method (Contractor Option): SMACNA Seal Class A. Apply duct sealer to transverse joints, longitudinal seams, fitting connections, corners of four-bolt or corner clip duct connection system, and fitting seams except continuous welded type. Spiral seams, continuous welded seams, and transverse joints for 4-bolt or corner clip duct connection system are not required to be sealed unless visible and audible leaks exist or duct leakage exceeds that allowed by leakage test specified in this section. Comply with manufacturer’s recommendations.

D. Duct and Plenum Sealing, Aerosol-Based Sealing Method (Contractor Option):

1. Preparation:

a. Inspect air distribution systems for leakage sites and accumulation of dust and debris. Remove debris and dust and dirt greater than 1/8 inch thick.
b. Coordinate with other subcontractors to temporarily remove or protect control devices and fire and smoke detectors from aerosol particles as required by aerosol manufacturer.
c. Temporarily disable fire alarm devices and notify the AHJ.
d. Temporarily isolate air distribution equipment and cover air devices and similar items as required by aerosol manufacturer.
e. Protect occupied spaces from aerosol particles.

2. Duct Sealing:

a. Repair major leakage locations greater than 1/2 inch wide using mastic and fiberglass mesh tape per SMACNA.
b. Seal ducts internally using automated aerosolized sealant injection.
c. Prepare pre-sealing, post-sealing, and sealing profile reports for duct sections sealed.
d. Repair injection and test holes per SMACNA.

3. Duct Testing: Comply with requirements in Article “Pressure Testing for Leakage” in this section
4. Duct Re-assembly and Cleanup:

a. Coordinate with other subcontractors to reinstall control devices and fire and smoke detectors.
b. Coordinate with other subcontractors to enable fire alarm devices and notify the AHJ.
c. Remove isolation for air distribution equipment and remove covers from air devices and similar items and enable air distribution equipment.
d. Cleanup sealant residue from surfaces in occupied spaces.

3.5 FLEXIBLE DUCTS

A. Install per SMACNA Figures 3-10 and 3-11 except as noted below.

B. Connect to metal ducts with slip joint made using fire-resistant mastic and stainless steel or plastic machine-applied clamp. Cloth tape adhesive and duct tape not acceptable.

C. Five foot maximum length, fully extended. Generally install with straight sections, without bends. If bends are required, install with maximum one-90 degree bend, R/D=2.5 or greater. No kinks allowed. Sheet metal elbows to result in straight flexible duct runs acceptable.

D. Hang flexible duct on 5’ - 0” centers and at 90 degree bend with 1 inch wide flat steel strap to span at least 3 spiral wires. Maximum 1/2 inch sag per foot. Support shall not cause out-of-round shape.

E. Installation in corridor ceiling spaces where fire rating is required not allowed.

3.6 DUCT SOUNDLINING, FIBERGLASS

A. General: Install duct soundlining per SMACNA and NAIMA Standards and as required by this article. Apply adhesive for 100 percent coverage. Secure soundlining with mechanical fasteners at maximum 15 inch centers. Start fasteners within 2 inch of leading edge of each section and within 3 inch of leading edge of cross joints within duct section. Coat exposed and mating edges and seams to prevent exposed glass fiber. Install sheet metal nosings at transverse lining terminations. Duct dimensions indicated on the Drawings are net inside dimensions. Increase sheet metal dimensions to accommodate duct soundlining thickness.

B. Extent:

1. Supply air ducts, first 15 feet from HVAC unit including downstream of VAV and fan powered terminal units. Coordinate with requirements of Section 230700.
2. Grille and diffuser boxes and boots.
3. Transfer ducts.
4. Return and exhaust air ducts for first 15 feet from grille and an additional 15 feet from the HVAC unit.
5. Relief ducts.

C. Transportation and Handling:

1. Transport and handle in accordance with manufacturer's instructions.
2. Promptly inspect shipments to ensure that materials comply with requirements and are undamaged.
3. Provide equipment and personnel to handle materials by methods to prevent soiling, disfigurement, or damage.

D. Storage and Protection:

1. Store and protect in accordance with manufacturers' instructions.
2. Store with seals and labels intact and legible.
3. Store in weathertight, climate controlled enclosures in an environment favorable to materials.
4. Exterior storage not acceptable.
5. Use off-site storage and protection when site does not permit on-site storage or protection.
6. Use equipment and personnel to store materials by methods to prevent soiling, disfigurement, or damage.
7. Arrange storage of materials to permit access for inspection. Periodically inspect to verify materials are undamaged and are maintained in acceptable condition.
8. Avoid installation of soundlined duct in exterior conditions (prior to enclosure of building exterior envelope). If it is absolutely necessary to install soundlined duct prior to building enclosure, provide temporary enclosures with impervious sheet covering arranged to shed water, anchored securely against the wind. Ventilate building to prevent condensation and degradation of materials.

E. Protection of Installed Work:

1. Provide temporary and removable protection for installed soundlining. Use durable sheet materials.
2. Control activity in immediate work area to prevent damage.

3. Install protective coverings at openings.
4. Prohibit traffic or storage upon installed surfaces.

F. Moisture: Do not allow soundlining to get wet or absorb moisture. Promptly remove and dispose of wetted or moist soundlining material and replace with new, soundlining material. Drying out wetted duct lining material not acceptable.

G. Installation: For soundlined ducts, use care during installation to insure that soundlining remains clean and dry, and that no gap will result between sections of duct soundlining after assembly of duct sections. Installation shall result in adjacent soundlined sections butted together without gaps, bulges, or other discontinuities. Ensure that mating edges are sealed in the field. Apply additional sealant to result in complete encapsulation of fibers.

3.7 DUCT SMOKE DETECTORS

A. Coordinate location requirements with Division 28 work prior to preparing and submitting sheet metal Shop Drawings to comply with detector manufacturer's installation requirements. Install duct smoke detectors furnished by electrical subcontractor.

3.8 PRESSURE TESTING FOR LEAKAGE

A. Description: Test supply and return ducts including rectangular, round, and flat oval duct systems. Test medium and high pressure (3 inch w.g. and greater) ductwork systems. Test random sampling of 10 percent of low pressure (2 inch w.g. and less) ductwork systems as selected by the A/E. If tests achieve leakage rates in accordance with requirements of this section, remainder of systems do not need to be tested. If any test fails to meet requirements of this section, test low pressure (2 inch w.g. and less) duct systems in their entireties.

B. Test Standard: SMACNA Leakage.

C. Leakage Class (CL) is defined as $CL = F/P^{0.65}$ where:

1. F is leakage rate in cfm per 100 sq. ft of ductwork surface area.
2. P is static pressure at which test is conducted and duct construction class as specified in this section.

Duct Construction Class (Pressure Classification)	Leakage Class (CL)
1/2 inch w.g.	16
1 inch w.g.	16
2 inch w.g.	8
3 inch w.g.	4
4 inch w.g.	4
6 inch w.g.	2
10 inch w.g.	2

D. Test Apparatus: Portable blower with volume adjustment, flow measuring assembly for determining cfm of air being added to duct consisting of calibrated orifice mounted in straight tube with straightening vane and pressure taps, U-tube manometer, and calibration curve for orifice assembly. Submit test apparatus calibration certificate.

E. Test Procedures:

1. Test duct before insulation is installed.
2. Close off and seal openings in duct section to be tested. Connect test apparatus to duct by means of flexible duct.
3. Test for audible leaks as follows:

    a. Start blower with its control damper closed.
    b. Gradually open control damper until duct pressure reaches specified pressure classification.
    c. Survey joints and seams for audible leaks. Mark each leak and repair after shutting down blower. Do not retest until sealants have set.

4. After audible leaks have been sealed, retest. Seal and retest as necessary until maximum leakage is less than allowable amount as determined by defined leakage class as specified in this section.
5. Submit duct section data, calculations, and test results for each duct section.
6. Summation of leakage for sections shall not exceed total allowable system leakage. Base allowable leakage on total surface square footage of installed duct.
7. Test of each duct section may be witnessed by the A/E. Give at least 7 calendar days prior notice before such tests.

3.9 HVAC SYSTEMS TRAINING

A. Comply with requirements in Section 230810.

3.10 COMMISSIONING

A. Equipment and systems referenced in this section shall be commissioned per Section 230800. The Contractor has specific responsibilities for scheduling, coordination, test development, testing and documentation.

END OF SECTION 233100

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Description: The Work includes accessories for air distribution systems and associated appurtenances.

B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to the Work in this section.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.

B. Codes and Standards:

1. AMCA 500-D, Laboratory Methods of Testing Dampers for Rating.
2. AMCA 511, Certified Ratings Program – Product Rating Manual for Air Control Devices.
3. ARI 410, Forced-Circulation Air-Cooling and Air-Heating Coils.
4. ARI 880, Air Terminals.
5. ARI 885, Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminals and Air Outlets.
6. ASTM C 1071, Standard Specification for Fibrous Duct Lining Insulation (Thermal and Sound Absorbing Material).
7. ASTM E 84, Standard Test Method for Surface Burning Characteristics of Building Materials.
8. ASTM E 477, Standard Test Method for Measuring Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers.
9. NFPA 80, Standard for Fire Doors and Other Opening Protectives.
10. NFPA 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems.
11. NFPA 255, Standard Method of Test of Surface Burning Characteristics of Building Materials.
12. SMACNA Fire, Smoke and Radiation Damper Installation Guide.
13. SMACNA HVAC Duct Construction Standards, Metal and Flexible (SMACNA), Third Edition, 2005.
14. UL 181, Factory-Made Air Ducts and Air Connectors.
15. UL 555, Fire Dampers.
16. UL 555C Ceiling Dampers.
17. UL 555S, Smoke Dampers.
18. UL 723, Test for Surface Burning Characteristics of Building Materials.
19. UL 1995, Heating and Cooling Equipment.
20. UL 1996, Electric Duct Heaters.

1.3 SUBMITTALS

A. Comply with requirements in Division 01 and Section 230500.

B. Product Data: Submit manufacturer's technical product data and maintenance data for the following:

1. Volume dampers and quadrants.
2. Backdraft dampers.
3. Fire dampers including installation instructions.
4. Smoke dampers including installation instructions.
5. Combination fire/smoke dampers including installation instructions.
6. Access doors and frames.
7. Variable air volume (VAV) units.
8. Electric duct heaters
9. Duct silencers (sound traps).
10. Blank copy of start-up and test report forms.

C. Shop Drawings: Comply with requirements in Section 230500.

D. Test Reports:

1. Fire Damper Log: Prior to air handling system startup, submit fire damper log. Log shall consist of an Excel spreadsheet listing each fire damper, ceiling radiation damper, smoke damper, and combination fire/smoke damper installed, type of damper, location, size, electrical connection information and date tested. Include additional comments for miscellaneous information.
2. Factory test reports for duct silencers (sound traps).
3. Submit completed copy of reports and include copy in the Operations and Maintenance Manual.

1.4 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION

A. Section 230900 – Automatic Temperature Controls: Motorized dampers and air terminal unit controllers and actuators.

B. Section 234100 – Filters: Duct mounted filter housings and filters during construction.

1.5 PRE-INSTALLATION MEETING

A. Prior to installing fire dampers, ceiling radiation dampers, smoke dampers, and combination fire/smoke dampers, sheet metal subcontractor shall arrange for and conduct a pre-installation meeting to review installation requirements. Meeting participants shall include at a minimum representatives from the general contractor, sheet metal, electrical and fire alarm subcontractors, AHJ, the A/E, mechanical engineer, and the Owner.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Comply with SMACNA.

2.2 VOLUME DAMPERS AND QUADRANTS

A. Factory Built Adjustable Dampers:

1. Description: Single or multiple blades, steel construction meeting SMACNA Standards for construction requirements for volume dampers.
2. Ratings and Standards: Maximum 4 inch w.g. pressure differential, 2000 fpm velocity and 180 F. Testing and ratings per AMCA 500-D.
3. Construction: Galvanized steel, 20 gage hat channel frame and 16 gage reinforced blades, linkage concealed in jamb, 1/2 inch diameter plated steel axles and control shaft, and synthetic sleeve type bearings.
4. Manufacturers: Greenheck Fan Corp. Model MBD-15, Air Balance, Inc., Ruskin Company, or approved.

2.3 BACKDRAFT DAMPERS

A. Description: Extruded aluminum frame and blades, extruded vinyl edge seals mechanically locked into blade edge. Blades with field adjustable, zinc plated steel counterbalance weights to allow pressure relief to start opening at 0.01 inch w.g. and be fully open at 0.06 inch w.g. Corrosion resistant bearings, synthetic type. Linkage concealed in frame. Dampers designed for maximum 1500 fpm spot velocities and up to 4 inch w.g. back pressure.

B. Manufacturers: Ruskin Company Model CBD2, Greenheck Fan Corp., Nailor Industries, Inc., or approved.

2.4 FIRE DAMPERS

A. Description: Fire dampers, each with frame and sleeve for wall and, floor installations. Comply with SMACNA. Include UL Fire Resistance Classified Ceiling Diffuser Radiation shields where installed at ceiling diffusers and grilles in fire rated ceilings.

B. Classification: UL 555, NFPA 90A. UL listed and labeled for dynamic systems with airflow in either direction. Include label indicating maximum allowable air quantity of 11 cfm/sq ft at 8 inch w.g. for fan driven air flow installations and 8 cfm/sq ft at 4 inch w.g. for relief and transfer air installations. 1-1/2 hour fire rated in general. Refer to Architectural drawings for fire ratings of general construction.

C. Type: Metal curtain folding type with replaceable 165 F fusible link, steel; spring closing for horizontal installations. Blades recessed out of airstream for 100 percent free area.

D. Sleeves: Galvanized steel, gage as required to meet manufacturer’s installation instructions, factory mounted to damper with sealant between sleeve and damper.

E. Manufacturers: Ruskin Company, Air Balance, Inc., Nailor Industries, Inc., or Greenheck Fan Corp.

2.5 COMBINATION FIRE/SMOKE DAMPERS

A. Description: Combination fire/smoke dampers, each with frame, sleeve, airfoil blades, and actuator for wall, floor, and ceiling installations. Comply with SMACNA. Include UL Fire Resistance Classified Ceiling Diffuser Radiation shields where installed at ceiling diffusers and grilles in fire rated ceilings.

B. Classification: UL 555, UL 555S, NFPA 90A, Leakage Class 1. UL listed and labeled for dynamic systems with airflow in either direction. Include label indicating maximum allowable air quantity of 11 cfm/sq ft at 8 inch w.g. for fan driven air flow installations and 8 cfm/sq ft at 4 inch w.g. for relief and transfer air installations. 1-1/2 hour fire rated in general. Refer to Architectural drawings for fire ratings of general construction.

C. Performance Rating: AMCA listed and labeled meeting AMCA 511 certifying air performance and air leakage performance.

D. Size: Free area inside sleeves and within damper stop minimum 90 percent of area of connecting duct. Provide larger damper size to maintain 90 percent free area. Increase size of damper if duct sizes indicated on the Drawings are smaller than manufacturer's available sizes.

E. Blades: Airfoil type, double skin, 6 inch maximum width. Single airfoil shaped blade for blade width extensions.

F. Heat-Actuated Temperature Release Device: Electric fuse link for controlled closure and automatic reopen after test, smoke detection, and power failure. 165 F activation temperature for duct air temperature less than 115 F and 212 F for duct air temperatures 115 F and higher, 250 F elevated temperature rated.

G. Sleeves: Galvanized steel, gage as required to meet manufacturer's installation instructions, factory mounted to damper with sealant between sleeve and damper.

H. Actuator: Factory installed, electric, 120 V, 60 cycle, 1 phase, actuator and linkage mounted out of air stream, normally closed (damper closes when power is interrupted). Actuator "clamped" to shaft (slide-on installation not acceptable). Electric actuators with 5 year warranty, microprocessor based controller with electronic cutoff at full open, incapable of burning out if stalled before full rotation is reached, maximum 0.23 Amp when running and 0.1 Amp at full open, and auxiliary switch. Belimo Aircontrols (USA), Inc. FSNF120-US Series. No substitutions. Include monitoring of blade damper position to DDC system specified in Section 230900. Coordinate with controls subcontractor specified in Section 230900 to review and confirm configuration of actuator location. Do not order damper and actuator until documentation has been received.

I. Manufacturers: Ruskin Company Model FSD60, Air Balance, Inc., Nailor Industries, Inc., or Greenheck Fan Corp.

2.6 ACCESS DOORS AND FRAMES

A. General: Include access doors wherever access to ducts is necessary for reaching equipment. Double construction, hemmed edges (no sharp edges), tight fitting with gasket, hinged, with latch, and insulation or soundlining equivalent to that of adjacent duct. Steel angle frame. Access panels with sheet metal fasteners not acceptable.

B. Access Door Sizes:

1. One-Hand or Inspection Access: 8 inch by 5 inch.
2. Two-Hand Access: 12 inch by 6 inch.
3. Head and Hand Access: 18 inch by 10 inch.
4. Head and Shoulders Access: 21 inch by 14 inch.
5. Body Access: 25 inch by 14 inch.
6. Body plus Ladder Access: 25 inch by 17 inch.

C. Latches: Die-cast, Ventfabrics, Inc. No. 100 for doors 2' - 0" high and smaller. Cat. No. 260 for doors up to 3' - 0" high. Cat. No. 310 for doors higher than 3' - 0". Use 2 for each door. Cam latches acceptable.

D. For Medium Pressure Rectangular, Round, and Flat Oval Ducts for Access to Combination Fire/Smoke Dampers: Combination access and pressure relief type or sandwich type with latches, retaining chain, and handle. Round or rectangular door to suit installation and access requirements. Access doors per manufacturer's standard sizes with maximum possible size for duct dimensions. Solid metal construction except insulated type where duct is insulated or constructed with duct soundlining. McGill AirFlow LLC, Ductmate Industries Inc, or approved.**]**

E. Type I Hood Exhaust Duct: Grease and airtight, UL 1978 listed and labeled, meeting NFPA 96 standards and mechanical codes. Access doors sandwich type or with weld-on frame with or without hinge.

2.7 VARIABLE AIR VOLUME (VAV) UNITS

A. Description: Pressure independent, VAV units used to regulate airflow and/or heat to zone in response to zone temperature requirements.

B. Agency Listings: UL listed and labeled or ETL. Certified under ARI 880 Certification Program. Include ARI seal. Sound performance certified in accordance with ARI 885.

C. Construction - General:

1. Casing: Minimum 22 gage galvanized steel, height as required to fit in available space. Maximum leakage 10 cfm at 1.0 inch w.g. differential static pressure.
2. Insulation – Double Wall Type: Interior surface of 20 gage unit casing acoustically and thermally lined with 1 inch thick matt faced insulation between solid 22 gage internal sheet metal. UL listed and labeled meeting UL 1995 and UL 181.
3. Primary Air Damper: Low-leakage with provisions for connecting actuator, maximum leak rate 9 cfm at 1 inch w.g. differential static pressure. Solid shaft rotating in Delrin or bronze oilite self-lubricating bearings. Shaft clearly marked on end to indicate damper position. Mechanical stop to prevent overstroking. Synthetic seals. Inlet sized to fit standard round duct.
4. Primary Airflow Sensor: Integral flow-cross style multiple point, center averaging flow sensor for primary air flow measurement. Include integral flow taps and calibration chart on each unit. Annular type sensor not acceptable.
5. Access Panel: Removable insulated panel on bottom of unit for access to interior of unit.
6. Discharge Duct Connection: Slip and drive rectangular connection.
7. Control Enclosure: Galvanized steel, with single point power supply connection and terminal block, control terminal block.

8. Digital Controller: Microprocessor-based controller furnished under Section 230900, factory installed by VAV unit manufacturer.
9. Primary Air Damper Actuator: Furnished under Section 230900, factory installed by VAV unit manufacturer on outside of housing. Installation inside control enclosure not acceptable.

D. Heating Water Coil:

1. General: Factory mounted, installed at discharge of unit, galvanized steel casing.
2. Extension sheet metal transition as required to limit coil face velocity to scheduled values indicated on the Drawings. Length to result in maximum 45 degree airflow transition angle from fan discharge to coil.
3. Coil Performance: Based upon ARI 410
4. Coil: Seamless copper tubes of minimum 0.016 inch thick wall with male solder header connections, tubes mechanically expanded into aluminum fin collars, maximum fin spacing of 12 fins per inch, leak tested at 300 psig.

E. Warranty: Single source by VAV unit manufacturer, including controls.

F. VAV Unit Component Responsibility: VAV unit manufacturer shall coordinate shipping. Refer to Article “VAV Unit and FTU Component Responsibility Schedule” in this section.

G. Manufacturers: Titus, Nailor Industries, Inc., ENVIRO-TEC®, or approved.

PART 3 - EXECUTION

3.1 INSPECTION

A. Description: Verify installation conditions as satisfactory to receive the Work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

3.2 PREPARATION

A. Field Measurements: Field verify locations of new and existing work prior to commencing the Work of this section.

B. Protection: Protect surrounding areas and surfaces to preclude damage from the Work of this section.

3.3 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

A. General: Install, apply, erect, and perform the Work in accordance with Article “Quality Assurance”, provisions, specifications, and manufacturer’s installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

B. Do not cover up or enclose work until inspected and approved. If in non-compliance, uncover work, remove, and provide new to satisfaction of the A/E at no additional cost to the Owner.

3.4 VOLUME DAMPERS

A. General: All required volume dampers are not shown on the Drawings. Install damper in duct to each supply, return, and exhaust opening and for branch mains serving more than 1 opening.

B. Construction and Installation: Install factory built adjustable dampers with actuators with metal fasteners. Use of factory applied adhesive seal without fasteners not acceptable. In general, arrange with axis of blade in long dimension of rectangular duct. Install bearing on each end. Seal installation airtight.

C. Location: Install dampers in accessible locations. Locate as far from outlet and inlet as possible.

D. Remote Cable Control System: Install where ducts are not accessible. Install cables for multiple dampers and routed to common location as directed by the A/E.

E. Setting: Set and lock in full open position, prior to TAB work.

F. Install 12 inch long orange colored 1/2 inch wide surveyors tape on quadrant of volume dampers located above ceilings.

3.5 BACKDRAFT DAMPERS

A. General: Install at exhaust and relief air duct terminations to atmosphere unless noted otherwise on the Drawings.

3.6 FIRE DAMPERS, CEILING RADIATION DAMPERS, SMOKE DAMPERS, AND COMBINATION FIRE/SMOKE DAMPERS

A. General: Install per manufacturer’s installation instructions. Install to prevent rattling and vibration. Utilize sleeves, angles and other materials so that installation is equivalent to that used by manufacturer when tested by UL.

B. Actuators: Install smoke and combination fire/smoke dampers so that actuators and other components mounted external to the damper are accessible. Install dampers so that actuators can be removed from damper shaft for replacement.

C. Testing: Test fire dampers, ceiling radiation damper, smoke dampers, and combination fire/smoke dampers per IBC, IFC, NFPA 80, and NFPA 105.

3.7 ACCESS DOORS

A. General: Install at duct smoke detectors, backdraft dampers, motorized dampers, fire dampers, smoke dampers, combination fire/smoke dampers, both sides of duct mounted coils, airflow measuring units, duct sensors, and plenums. Arrange door swings so that access doors open against air pressure.

B. Access Doors for Fire Dampers, Smoke Dampers, and Combination Fire/Smoke Dampers:

1. Size large enough to permit replacement of fusible link, resetting of damper, and damper inspection. Minimum dimension 12 inch or maximum dimension allowed by duct size.
2. Hinged and latched, or clamped with mechanism to allow easy removal.
3. Tight fitting, full neoprene gasketed, constructed to prevent air leakage.
4. Install permanent engraved phenolic nameplates in accordance with Section 230510, IBC, and IMC. Color as selected by the AHJ.
5. Demonstrate to the Owner and A/E that fusible link can be replaced, damper can be reset, and damper can be inspected for up to 5 fire damper locations and for up to 5 smoke and combination fire/smoke damper locations as selected by the A/E.

3.8 VARIABLE AIR VOLUME TERMINAL UNITS

A. General: Install to be accessible for service and maintenance to components by maintenance personnel standing on ladder, without need to reach over or around light fixtures, ceiling supports, piping, and similar obstructions. Components needing service and maintenance include but are not limited to filters, controls, valves, strainers, fan motors, starters, disconnect switches, damper actuators, and airflow sensors.

B. Coordination: Units located above inaccessible suspended ceilings will require access through access doors. Coordinate requirements for right or left hand access and connections to suit field connections. Access doors will be furnished and installed as part of general construction work but sizes shall be determined as part of the sheet metal work.

C. Support units from structure similar to that for ducts and per details on the Drawings. Support devices shall not block access.

D. Provide ceiling “dots” under the service and maintenance locations of each unit to allow maintenance personnel to identify locations of ceiling panels that need to be removed and reinstalled to access components. Obtain A/E approval of products to be used for this purpose and their method of attachment to ceiling.

3.9 FILTERS

A. Duct Mounted Filter Housings: Install housings specified in Section 234100 as indicated on the Drawings. Locate and arrange to allow easy access to replace filters.

3.10 HVAC SYSTEMS TRAINING

A. Comply with requirements in Section 230810.

3.11 COMMISSIONING

A. Equipment and systems referenced in this section shall be commissioned per Section 230800. The Contractor has specific responsibilities for scheduling, coordination, test development, testing and documentation.

3.12 VAV UNIT COMPONENT RESPONSIBILITY SCHEDULE

ITEM	FURNISHED BY	MOUNTED BY	CONNECTED BY
1. VAV Unit	Unit Manufacturer	Mechanical Contractor	Mechanical (1) Contractor
2. Primary Air Damper Actuator	Control Subcontractor	Unit Manufacturer	Unit Manufacturer
3. Primary Airflow Sensor	Unit Manufacturer	Unit Manufacturer	Unit Manufacturer
4. Heating Water Coil	Unit Manufacturer	Unit Manufacturer	Mechanical Contractor
a. Heating Coil Control Valve	Mechanical Contractor	Mechanical Contractor	Mechanical Contractor
b. Control Valve Actuator	Control Subcontractor	Control (3) Subcontractor	Control Subcontractor]
5. Low Voltage Field (4) Wiring			Control Subcontractor
6. Air Flow Transducer	Control Subcontractor	Control (2) Subcontractor	
7. Temperature Sensor	Control Subcontractor	Control Subcontractor	Control Subcontractor
8. Digital Controller	Control Subcontractor	Unit (2) Manufacturer	

Notes:
1. Duct and piping connections.
2. Internal tubing and wiring by unit manufacturer, external (field) wiring by control subcontractor.
3. If not integral to control valve.
4. 24 V control power connected by control subcontractor.

END OF SECTION 233300

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Description: The Work includes air handling units, heat recovery units, fans, fan drives, and associated appurtenances.

B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to the Work in this section.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.

B. Codes and Standards:

1. AHRI 410, Forced-Circulation Air-Cooling and Air-Heating Coils.
2. AHRI 1060, Performance Rating of Air-to-Air Heat Exchangers for Energy Recovery Ventilation Equipment.
3. AMCA Publication 99, Standards Handbook.
4. AMCA Standard 204, Balance Quality and Vibration Levels for Fans.
5. AMCA Standard 210, Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
6. AMCA Publication 211, Certified Ratings Program – Product Rating Manual for Fan Air Performance.
7. AMCA 300, Reverberant Room Method for Sound Testing of Fans.
8. AMCA Standard 301, Methods for Calculating Fan Sound Ratings from Laboratory Test Data, as tested to AMCA 300.
9. AMCA Publication 311, Certified Ratings Program – Product Rating Manual for Fan Sound Performance.
10. AMCA Standard 320, Laboratory Methods of Sound Testing of Fans Using Sound Intensity.
11. AMCA Standard 500-D, Laboratory Methods of Testing Dampers for Rating.
12. AMCA Publication 511, Certified Ratings Program – Product Rating Manual for Air Control Devices.
13. ARI 260, Sound Rating of Ducted Air Moving and Conditioning Equipment.
14. ARI 430, Central Station Air-Handling Units.
15. ASHRAE 84, Method of Testing Air-to-Air Heat Exchangers.
16. ASTM B 117, Standard Practice for Operating Salt Spray (Fog) Apparatus.
17. NFPA 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems.
18. UL 507, Standard for Electrical Fans.
19. UL 705, Power Ventilators.
20. UL 723, Standard for Test for Surface Burning Characteristics of Building Materials.
21. UL 1995, Heating and Cooling Equipment.

1.3 SUBMITTALS

A. Comply with requirements in Division 01 and Section 230500.

B. Product Data: Submit manufacturer's technical product data, ladder-type wiring diagrams differentiating between portions of wiring that are factory installed and portions to be field-installed, and maintenance data for each air handling unit as follows: Include dimensions, weights, capacities, certifications, component performance, electrical characteristics, casing construction details, wiring interconnections, gages, and finishes of materials.

1. Air handling units, custom.
2. Heat recovery units, custom.
3. Plenum fans.
4. In-line centrifugal fans.
5. Fan drives.
6. Blank copy of start-up and test report form.

C. Performance Data: Submit fan performance curve for each air handling unit, heat recovery unit and fan. Indicate on separate graph for each fan and for combined fans operating in parallel, static pressure versus volume flow, efficiency, and brake horsepower, with scheduled design point shown and labeled. Indicate that fan performance curve will not exceed 90 percent of maximum efficiency. Performance certified in accordance with AMCA 210. A single fan curve not acceptable. Include coil selection worksheets, showing consideration for altitude, air density, fluid characteristics, and fouling factor.

D. Test Reports:

1. Factory airflow, air leakage, panel deflection, sound, and flood test reports.
2. Field start-up test reports.
3. Submit completed copy of reports and include copy in the Operation and Maintenance Manual.

E. Sound Power Level Data:

1. Submit data plotting octave band frequencies from 63 Hz to 8000 Hz versus octave band sound power level, dB re: 10^{-12} Watt, for unit discharge and inlet. Performance certified in accordance with AMCA 300 and ARI 260.

1.4 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION

A. Section 230900 – Automatic Temperature Controls: Variable frequency drives.

PART 2 - PRODUCTS

2.1 AIR HANDLING UNITS AND HEAT RECOVERY, CUSTOM, INDOOR

A. General: Custom horizontal type air handling units as indicated on the Drawings with components for specified unit operation.

B. Shipping Splits: Ship unit in one piece, unless too large to be legally shipped by truck. If too large to ship as one piece, ship unit in sections for field assembly by the Contractor. Include detailed assembly instructions. Label parts and sections. Furnish assembly materials including insulation, sealant, fasteners, and hardware. Include joining flanges for unit base.

C. Casings:

1. General: Sections, dimensions, and service access spaces as indicated on the Drawings.
2. Construction:

   a. Custom arrangement, minimum 16 gage walls, top, and bottom or surfaces braced and reinforced to maintain leakage and casing deflection measured at mid-span not to exceed L/200 at 1.5 times operating pressure to maximum plus 10 inch w.g. for positive pressure sections and minus 10 inch w.g. for negative pressure sections where L is panel span.
   b. Units constructed with welded structural steel channel around entire perimeter with intermediate welded channel and angle iron supports.
   c. Floor 12 gage painted steel for units you can kneel in and 1/8 inch thick aluminum tread plate for units you can stand in (minimum 5’ - 6” high). Floor fully welded flat to structural channel with seams continuously welded or maximum deflection not to exceed L/200 with 200 pound point load.
   d. Casing double wall construction with galvanized Type 304 stainless steel perforated inner liner and galvanized Type 304 stainless steel exterior.
   e. Include minimum 1-1/2 inch high perimeter collar around the entire unit base and around each floor opening to ensure unit is internally watertight.
   f. Entire base shall act as an auxiliary drain pan and hold up to 1-1/2 inch of water.
   g. Units delivered in multiple sections sealed watertight at seams and joints and finished with painted metal protective cover strips.
   h. Include desiccants in each section within unit casing to protect against water build-up during shipping and prior to unit installation in final location.

3. Access Doors:

   a. Hinged and gasketed 16 gage, double thickness door with insulation and lining to match casing inner liner and casing thickness. Include mounting straps and gasketing.
   b. Hinges stainless steel, continuous piano type for doors 36 inch high and smaller and multiple heavy duty hinges for doors larger than 36 inch high and larger.
   c. Locate for access to internal equipment and mixing box sections. Minimum door opening size 24 inch wide. Minimum height 70 inch where unit height permits. Doors in fan sections sufficiently wide for removal of fan and motor. Door opening fully gasketed.
   d. Doors swing against air pressure. Minimum 2 high pressure latches operable from inside and outside of door. If doors do not open against pressure, include safety latches that allow access doors to partially open after first handle movement and fully open after second handle movement.
   e. Include double paned viewing window in fan, coil, filter, and mixing box section access doors. Minimum size 8 inch square or round diameter.

4. Insulation:

a. Include 4 inch thick, 3 pound per cubic foot density neoprene-coated fiberglass insulation for exterior mounted units and unfaced fiberglass insulation with Tedlar sheet for indoor units for walls and roof. Closed cell insulation with minimum R-value equal to fiberglass thickness filling entire panel cavity acceptable.
b. In fan section, include Tedlar sheet between insulation and perforated liner. Mylar sheet not acceptable.
c. Insulation edges protected with metal lagging.
d. Insulation systems using stick pins not acceptable.

5. Base:

a. Welded and painted structural steel channel at perimeter with intermediate welded channel and angle supports. Minimum height 8 inch to provide elevation of condensate drain pan outlet high enough to accommodate required condensate drain trap vertical dimensions.
b. Include lifting lugs, minimum 4 per unit section.
c. Underside of floor insulated with 2 inch thick fiberglass or polyurethane spray foam insulation with minimum R-value equal to fiberglass thickness.
d. Maximum base deflection L/1000 during rigging where L is distance between lifting lugs.

6. Finish:

a. Surfaces chemically cleaned, washed, dried, and coated with polyurethane primer and enamel finish to minimum 1-1/2 mil thickness. Enamel finish able to withstand salt spray test per ASTM B 117 for minimum 500 continuous hours.
b. Custom color as selected by the A/E.

7. Acoustical Performance: Unit maximum sound power level with unit installed components operating at design conditions not to exceed decibels (dB), re: 10^{-12} Watts listed in the following table per ARI 260. Refer to schedules on drawings for requirements.
8. Pipe and Conduit Penetrations: Sheet metal sleeve through. Seal and caulk to prevent air leakage.
9. Duct Connections: Include factory installed bellmouth collars for supply fan discharge connections, and rectangular collars for other duct connections.

D. Fan Sections, Centrifugal:

1. Type: Wheel with reinforced steel inlet plate with removable spun inlet cone and structural steel frame. Casing-mounted, AMCA labeled, direct drive. Fan construction and descriptive nomenclature in accordance with AMCA Publication 99. Fan tested, rated, and certified per AMCA 210 for air delivery and per AMCA 300 for sound power levels. Fan balancing process, including vibration limits and documentation performed per AMCA 204. Comply with Article “Plenum Fans” in this section.
2. Selection: Select centrifugal fans for point of design at maximum possible mechanical efficiency. At this point of design, fan characteristic curve shall continuously slope for at least 10 percent of fan static pressure, both above and below point of design.
3. Fan Housing: Steel construction, braced with structural steel for rigidity. Include full access to serviceable items.
4. Wheels: Blades continuously welded, die-formed, airfoil type. Tapered spun wheel cones or shrouds to provide stable air flow and high rigidity.

5. Fan Shafts: Solid, ground, and polished. Carbon steel, SAE 1045 material, machined to close tolerances. Key to fan wheel. Coat fan shaft with rust inhibitor after machining. Hollow shafts not acceptable.
6. Bearings: Ball or roller type, L-50 life at 200,000 hours, grease-lubricated. American Fan Bearing Manufacturers' Association Series FS (Fairly Silent) acoustical criteria at rotational speeds 1/3 of fan RPM or higher.
7. Balancing and Overspeed Requirements: Select fans not to pass through their first critical speed at any cataloged RPM. Size for first critical speed of at least 1.43 times maximum speed for the class. Rotors statically and dynamically balanced including overspeed test at 125 percent of normal. Shafts free from critical speeds within 125 percent of normal. Allowable vibration, peak-to-peak displacement, not to exceed 2.0 mils.
8. Motors: Comply with requirements in Section 230513. Locate on access door side of casing.

E. Fan Array Technology:

1. Description: Multiple, direct drive Arrangement 4 plenum fans, construction per AMCA Publication 99. Fans tested, rated, and certified per AMCA 210 for air delivery and AMCA 300 for sound power levels. Fan balancing process, including vibration limits and documentation performed per AMCA 204.
2. Construction: Galvanized steel intake wall, motor support plate and structure, and spun steel inlet funnel with powdered coated finish.
3. Motors: Comply with requirements in Section 230513. Include isolated bearing or shaft grounding for each fan.
4. Fan/Motor Assembly Control: Each assembly individually factory wired to control panel for control by single variable frequency drive (VFD).
5. Backdraft Damper: Include for each fan/motor assembly. Tested in accordance with AMCA Standard 500-D and certified for air performance and air leakage performance per AMCA 511. Ruskin Company BD6, TAMCO, or approved.

F. Heating and Cooling Coils:

1. Comply with requirements in Section 233300.
2. Support Frames:

    a. Fully enclosed within unit casing. Racks arranged to allow coils to slide out individually.
    b. Removable coil access panels for removal of coils through the casing wall.
    c. AHU Heating Coils: Galvanized steel support frames.
    d. AHU Cooling Coils: Stainless steel support frames.

G. Drain Pan:

1. Stainless steel construction, minimum 16 gage, 2-way sloping located under cooling coil sections to collect condensate from coils, headers, return bends, and uninsulated piping.
2. Extend pan downstream from cooling coil 18 inch or 1/2 height of cooling coil, whichever is longer.
3. Install pan to slope to drain.
4. Insulate exterior of drain pan to prevent condensation.
5. Include copper or stainless steel drain connections, minimum 1-1/2 inch diameter, or as indicated on the Drawings.

6. Include auxiliary drain pans in fan section downstream of cooling coil and in mixing box section.
7. When unit employs more than 1 stacked cooling coil section, include insulated, sealed, and sloped stainless steel intermediate drain pan. Include 1 inch stainless steel drain from upper drain pan(s) terminating over lowest drain pan.

H. Plenum Sections: Include minimum 15 inch length unless otherwise indicated on the Drawings. Include access door. In addition, include between heating coil and cooling coil for freezestat furnished and installed by control system subcontractor and for cleaning coil fins.

I. Filter Section: Rear access, where space is available, or side access filter housing with pre-filters and final filters. Comply with requirements in Section 234100.

J. Mixing Box Section:

1. Include mixing box with motorized dampers as integral part of air handling units.
2. Parallel blade type for throttling and two-position control. Orient outside air and return air dampers so that blades direct air toward each other. Size for 1200 to 1500 foot per minute face velocity.
3. Separate minimum and maximum outdoor air dampers as indicated on the Drawings.
4. Airfoil blade dampers constructed with extruded aluminum or steel blades with extruded vinyl or rubber edge seals. Blade ends sealed with stainless steel “arc” seals. External linkage controlled by separate actuators. Multiple sections of each damper linked together with welded connections.
5. Damper leakage rate not to exceed 3 cfm per square foot of damper area at 1 inch w.g. pressure.
6. Include shaft extension with positive actuator connection via flat spot on shaft for set screw or other non-slip mechanical connection.
7. Actuators furnished, installed, and wired by control system subcontractor specified in Section 230900. Mounting brackets by air handling unit manufacturer arranged to ensure that operators are mounted in easily accessible sections of unit.

K. Minimum Outside Air Dampers: Integral flow measuring station and modulating damper. Tested in accordance with AMCA Standard 500-D and as published in AMCA Publication 511. Trane® Traq™ Airflow Monitoring Systems, Ruskin Company IAQ damper as specified in Section 230900, or approved. Include factory mounted control panel.

L. Heat Exchanger Section: Aluminum plate, crossflow air-to-air type.

1. Construction:

   a. Minimum 0.008 inch thick aluminum plates with aluminum exterior frame. Galvanized steel frame not acceptable.
   b. Plates sealed to eliminate cross leakage without visible plate deflection at 10 inch w.g. pressure.

2. Heat Transfer Surface: Visible for inspection and cleaning for both exhaust and supply sides without requiring removal of access panels.
3. Drain Pan:

   a. Stainless steel construction, minimum 18 gage, under heat exchanger section and for supply and exhaust sides of heat exchanger.

b. Insulate exterior of drain pan to prevent condensation.
c. Include copper drain connections, minimum 1 inch diameter, or as indicated on the Drawings.

M. Electrical Panel:

1. Description:

a. UL or ETL listed and labeled.
b. Factory wired and tested prior to shipment.
c. NEMA 1 construction mounted on unit fan casing with separate power and secondary 120 V compartments.
d. Controls and other electrical components within casing. Casing penetrations sealed to eliminate air leaks.
e. Single point power supply connection.
f. Integral transformer with disconnect and fuses for 120 V duplex receptacles, lighting, and control loads.

2. Code Required Accessories: Include factory mounted electrical and mechanical code required accessories and as follows:

a. Horsepower and full load current rated disconnecting means.
b. Overcurrent protection (main and internal subcomponent).
c. Motor control with running overload protection.
d. Electrical installation instructions.

3. Components and Wiring: Comply with NEC and requirements in Division 26. Number coded per wiring diagrams. Label electrical components per wiring diagrams.
4. Terminals: Include terminal block for main power connection, and terminal board for low voltage control wiring. Include knockouts in bottom of main control panel for field wiring entrance.
5. Fan Branch Circuits: Individually fused. Final electrical connection to fan motor made with flexible conduit sufficiently long for vibration isolation.
6. Lighting: 25 Watt interior vapor-tight fixture with protective metal cage for each accessible compartment. Locate common weatherproof switch with pilot light on outside of unit near an access door.
7. Disconnects:

a. Lockable door-interlocked main disconnect to isolate components except receptacles, interior lighting, and controls.
b. Secondary circuit breaker for duplex receptacles.
c. Secondary circuit breaker for lighting.
d. Four 20 Amp secondary circuit breakers for controls.

8. Sound Tests: Factory test to ensure sound power levels using procedures per AMCA 320 do not exceed sound power levels specified in this section.

N. Instrument Test Holes: Include test ports for unit static pressure testing between each component of unit. Duro Dyne Corp. IP-4 or approved.

O. Manufacturers: Petra Engineering Industries Co. Ltd, Dynamic Air Technology, Inc., Haakon Industries, Governair, Huntair Inc, or approved.

2.2 PLENUM FANS

A. Description: Unhoused, centrifugal type and direct drive as indicated on the Drawings. Tested, rated, and certified in accordance with AMCA 210 for air delivery and AMCA 300 for sound power levels. Fan balancing process, including vibration limits and documentation performed per AMCA 204. Include AMCA label. Factory tested at scheduled fan RPM.

B. Construction:

1. Class per AMCA Publication 99 for air quantity and static pressure as scheduled, steel framework, bearing support structure, and inlet panel, AMCA Arrangement 4 for direct drive.
2. Wheel: Non-overloading, backward inclined with airfoil blades, aluminum, statically and dynamically balanced.
3. Bearings: Self aligning ball or roller pillow block type, L-50 life at 200,000 hours, grease lubricated.
4. Finish: Steel components finished with electrostatically applied backed polyester urethane powder coating.

C. Motor: Comply with requirements in Section 230513.

D. Manufacturers: Greenheck Fan Corporation Model QEP, Loren Cook Company, Huntair Inc., Twin City Fan & Blower, or approved.

2.3 IN-LINE CENTRIFUGAL FANS

A. Description: Direct drive in-line centrifugal fan as indicated on the Drawings. Arrangement, accessories, and motor as indicated in the Contract Documents. UL listed and labeled.

B. Construction:

1. Housing: Galvanized steel, internally lined with 1 inch thick fiberglass neoprene coated duct liner with exposed edges sealed with adhesive. Include access panel, self-contained removable drive door, adjustable motor base, belt tunnel, support brackets, automatic belt tensioner, and inlet and outlet duct connections. Baked enamel finish.
2. Wheel: Aluminum, backward inclined, statically and dynamically balanced.
3. Bearings: Self-aligning, relubricable ball type with cast iron flanges and locking collars, L-50 life at 200,000 hours.

C. Motor: Comply with requirements in Section 230513.

D. Electrical:

1. Factory wired from junction box mounted on exterior of unit to motor. Electrical connection to fan motor made with flexible conduit sufficiently long for vibration isolation.

E. Manufacturers: Greenheck Fan Corporation SQ Series, Loren Cook Company, or approved.

2.4 FAN DRIVES

A. Description: Cast iron drives rated for air handler use for belt drive fans as indicated on the Drawings.

B. Type:

1. 10 hp and Smaller: Variable pitch V-belt sized for 175 percent of motor horsepower. Minimum 2 belts for motors 5 hp and larger.
2. 15 hp and Larger: Fixed pitch V-belt sized for 175 percent of motor horsepower. Minimum 2 belts.

C. Belts: Grip notch type factory or field installed. Browning Gripbelt or approved.

D. Drive Ratio: Drive ratio to give required CFM at static pressure of system. In each case, if during balancing, static pressure in any system is found to vary from that indicated on the Drawings, change drive ratio at no extra cost to the Owner.

PART 3 - EXECUTION

3.1 INSPECTION

A. General: Verify installation conditions as satisfactory to receive the Work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

3.2 PREPARATION

A. Field Measurements: Field verify locations of new and existing work prior to commencing the Work of this section.

B. Protection: Protect surrounding areas and surfaces to preclude damage from the Work of this section.

3.3 INSTALLATION, APPLICATION, ERECTION AND PERFORMANCE

A. Description: Install, apply, erect, and perform the Work in accordance with Article “Quality Assurance” provisions, specifications, and manufacturer’s installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

B. Coordinate with ductwork and piping as necessary to interface installation of air handling equipment and access to components.

C. Coordination: Coordinate required electrical and control installation work with Division 26 and Section 230900.

3.4 WORK PRIOR TO INSTALLATION

A. Equipment manufacturer's authorized representative shall maintain personnel within a 50 mile radius of job site. Representative capable of troubleshooting air handling unit faults.

1. Include 1 man day to meet with mechanical, electrical and control subcontractors and mechanical engineer at job site. Schedule this meeting within 1 week after equipment is delivered to final location at job site but prior to equipment operation. Purpose is to assure that all parties understand what interconnections are required.
2. After equipment installation, include 1 man day to assist control and electrical subcontractors in termination of interconnecting wires in unit mounted control panels. This service shall also verify proper connection and polarity of wires.

3.5 INSTALLATION OF AIR HANDLING EQUIPMENT AND COMPONENTS

A. Install equipment with clearances for service and maintenance.

B. Repair damaged heating and cooling coil fins.

C. Floor Mounted Air Handling Units:

1. Install on level surface.
2. Anchor bolt to housekeeping pads.
3. Seal floor penetrations watertight.

D. Suspended Fans and In-Line Exhaust Fans: Provide hanger rods to support fan unit from slab above or from roof structure. Comply with requirements in Section 230510 for formed steel channels and supplementary steel framing, Section 230548 for vibration isolators, and Section 230550 for seismic restraints.

E. Air Measuring Units: Install units furnished under Section 230900.

F. Duct Silencers (Sound Traps): Install duct silencers furnished under Section 233300.

3.6 CLEANING

A. Air handling equipment shall remain sealed except during installation. When daily activities have been completed, clean and seal unit. Do not use compartments for storage.

B. Thoroughly clean plenums and casings of debris and blow free small particles of rubbish and dust before making final duct connections. Prior to startup, clean to remove traces of oil, dust, and dirt. Vacuum clean fan wheels, exterior surfaces of casings, and entering air face of coils.

3.7 START-UP SERVICES

A. Equipment manufacturer's authorized representative shall perform start-up services of air handling units and related appurtenances. Services shall include a check of proper installation, system check-out, adjustment, and complete start-up. Start-up by Contractor not acceptable.

B. Coordinate start-up services with air distribution system operation as specified in Division 01 and Section 230500 and TAB work specified in Section 230593.

3.8 ADJUSTING

A. Tighten belts to proper tension. Adjust fans and provide drive changes to deliver design airflow. Comply with requirements in Section 230593.

B. Adjust damper linkages for proper damper operation.

3.9 HVAC SYSTEMS TRAINING

A. Comply with requirements in Section 230810.

B. Representative shall conduct two 4 hour training sessions to demonstrate that equipment operates as indicated in the Contract Documents and in accordance with manufacturer's recommendations. First session shall cover operation of air handling equipment. Second session shall cover detailed system operation and trouble shooting. Give minimum one week notice prior to demonstration. Furnish instruments and personnel required to conduct the demonstration.

C. Starting time (during any normal operating shift) of training sessions will be determined by the Owner to minimize overtime required for his maintenance personnel.

D. Demonstrate proper performance of operating and safety controls, as well as stable equipment performance over entire operating range to satisfaction of the Owner prior to Substantial Completion.

E. Include instruction session to identify locations of servicing points and required maintenance requirements to Owner's personnel.

F. Include preliminary discussion and presentation of information from instruction manuals, with appropriate references to the Contract Documents, followed by tour explaining maintenance requirements, access methods, servicing and maintenance procedures, equipment cleaning procedures, control settings and available adjustments.

3.10 COMMISSIONING

A. Equipment and systems referenced in this section shall be commissioned per Section 230800. The Contractor has specific responsibilities for scheduling, coordination, test development, testing and documentation.

END OF SECTION 233400

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Description: The Work includes grilles, diffusers, louvers and associated appurtenances.

B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to the Work in this section.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.

B. Codes and Standards:

1. AAMA 2605, Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Architectural Extrusions and Panels.ADC 1062R4, Air Diffusing Equipment Certification, Rating and Test Manual.
2. AMCA 511, Certified Ratings Program – Product Rating Manual for Air Control Devices.
3. ASHRAE 70, Method of Testing for Rating the Performance of Air Outlets and Inlets.
4. ASTM B 221, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
5. ASTM C 578, Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
6. ASTM C 612, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
7. ASTM D 523, Standard Test Method for Specular Gloss.
8. ASTM D 2244, Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates.
9. ASTM D 4318, Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
10. ICC Evaluation Service AC 167, Acceptance Criteria for Fabric Air Dispersion Systems.
11. NFPA 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems.
12. UL 2518, Outline of Investigations for Air Dispersion Systems Materials.

1.3 SUBMITTALS

A. Comply with requirements in Division 01 and Section 230500.

B. Product Data: Submit manufacturer’s technical product data and maintenance data for each type of the following:

1. Grilles, registers, and diffusers.
2. Louvers.

C. Color samples for air dispersion system.

D. Color chart for louvers.

PART 2 - PRODUCTS

2.1 GRILLES, REGISTERS, AND DIFFUSERS

A. Except as otherwise indicated, furnish manufacturer's standard grilles and diffusers of size, shape, capacity and type as indicated on the Drawings for complete installation.

B. Performance: Furnish grilles and diffusers that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each grille and diffuser type and size as listed in manufacturer's current data.

C. Ceiling Compatibility: Furnish with border styles compatible with adjacent ceiling systems specifically manufactured to fit into ceiling module with accurate fit and adequate support. Refer to architectural drawings and specifications for types of ceiling systems.

D. Seismic Restraints for Grilles and Diffusers Weighing Less than 20 Pounds: Include means to positively attach grilles and diffusers to ceiling grid system.

E. Manufacturers General: Titus, Krueger-HVAC, Anemostat, Metalaire™, Kees,Inc., Tuttle & Bailey®, Nailor Industries Inc., Price Industries, or approved.

F. Manufacturers – Displacement and Raised Floor Ventilation: Titus, Trox REPUS Series, Halton Company, Price Industries, or approved.

2.2 LOUVERS

A. General: Four inch deep, extruded aluminum with drainable blade design and jamb mounted downspouts and birdscreen.

B. Performance: Maximum free area and minimum pressure drop for each type as listed in manufacturer's current data. Louver licensed to bear AMCA Certified Ratings Program seal for air performance and air and water penetration in accordance with AMCA 511. Substrate Compatibility: Include frame and sill styles compatible with adjacent substrate specifically manufactured to fit into construction openings with accurate fit and adequate support for weather-proof installation. Refer to architectural drawings and specifications for types of substrate where louvers will be installed.

C. Materials: Aluminum extrusions, ASTM B 221, Alloy 6063-T5. Weld units or use stainless steel fasteners. Comply with NAAMM "Metal Finishes Manual" to provide uniformly finished products.

D. Louver Screens: On inside face of exterior louvers, 1/2 square mesh, 16 gage, anodized aluminum wire mounted in removable extruded aluminum frames.

E. Hinged Option: Include hinged louver option for **ALL LOUVERS**. Louvers shall be lockable.

F. Blank Off Panels: Include blank off panels mechanically fastened to inside face of louver as indicated on the Drawings. Panel with 2 inch thick rigid cellular extruded polystyrene insulation,

minimum R-value 5.0 per inch of thickness at 75 F mean temperature, ASTM C 578, minimum density 1.5 pound per cubic foot. Finish same as louver.

G. Finish: Two coat 70 per cent/Kynar 500®/Hylar 5000® per AAMA 2605, 1.2 mil dry film thickness**.** Custom colors are required.

H. Manufacturers: Greenheck Fan Corporation Model ESD-435, Ruskin Company Model ELF375DX, Airolite, American Warming and Ventilating Co., Louvers & Dampers, Construction Specialties, Inc., Nailor Industries Inc, or approved.

PART 3 - EXECUTION

3.1 INSPECTION

A. General: Verify installation conditions as satisfactory to receive the Work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

3.2 PREPARATION

A. Field Measurements: Field verify locations of new and existing work prior to commencing the Work of this section.

B. Protection: Protect surrounding areas and surfaces to preclude damage from the Work of this section.

3.3 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

A. General: Install, apply, erect, and perform the Work in accordance with Article “Quality Assurance” provisions, specifications, and manufacturer’s installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

B. Coordinate with other work, including ductwork and duct accessories, as necessary to interface installation of grilles and diffusers with other work.

C. Install grilles and diffusers level and plumb.

D. Install grilles and diffusers with airtight connection to ducts and to allow service and maintenance of adjustable components.

E. Ceiling-Mounted Air Devices: Drawings indicate general arrangement of ducts, fittings, and accessories. Grille and diffuser locations have been indicated on the Drawings to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated on the architectural reflected ceiling plans. For grilles and diffusers installed in lay-in ceiling panels, locate in center of panel. Where architectural features or other items conflict with installation, notify A/E for determination of final location.

F. Seismic Restraints:

1. For Grilles and Diffusers Weighing Less than 20 Pounds: Positively attach grille and diffuser to ceiling grid system.
2. For Grilles and Diffusers Weighing 20 to 56 Pounds: In addition to positively attaching grille and diffuser to ceiling grid system, install two No. 12 gage hanger wires connected to grille and diffuser to ceiling system hanger or to structure above.
3. For Grilles and Diffusers Weighing More than 56 Pounds: Support directly from structure above. Comply with requirements in Section 230550 for seismic restraints.

G. Connect ducts to louvers as indicated on the Drawings. Apply sealant to make installation watertight.

H. Anchor sleeves for brick vents to wall opening.

3.4 ADJUSTING

A. After installation, adjust grilles and diffusers to air patterns indicated on the Drawings, or as directed by the A/E before starting air balancing.

3.5 CLEANING

A. After installation of grilles and diffusers, inspect exposed finish. Clean exposed surfaces to remove burrs, dirt, and smudges. Remove and provide new grilles and diffusers that have damaged finishes.

END OF SECTION 233700

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Description: The Work includes air filters for air handling equipment and associated appurtenances.

B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to the Work in this section.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.

B. Codes and Standards:

1. ASHRAE 52.2 Method of Testing General Ventilation Air--Cleaning Devices for Removal Efficiency by Particle Size.
2. NFPA 90A, Standard for the Installation of Air--Conditioning and Ventilating Systems.
3. UL 867, Standard for Electrostatic Air Cleaners.
4. UL 900, Standard for Air Filter Units.
5. UL 916, Standard for Energy Management System.

1.3 SUBMITTALS

A. Comply with requirements in Division 01 and Section 230510.

B. Product Data: Submit manufacturer’s technical product data and maintenance data for the following:

1. Final filters.
2. Filter housings and frames.
3. Resistance indicator.
4. Filters during construction.
5. Blank copy of start--up and test report forms.

C. Test Reports:

1. Start--up and test reports.
2. Submit completed copy of reports and include in the Operations and Maintenance Manual.

D. Certification: Submit certificate signed by the Owner as to receipt of spare filters.

1.4 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Section 233300 – Air Distribution Accessories: Duct mounted filter housings and filters during construction.

1.5 SPARE MEDIA

A. For Air Handling Units, Heat Recovery Units, Packaged HVAC Equipment, Fuel Fired Heating Equipment, FTUs, and Similar Equipment with Filters: Four sets for each type of filter. One for initial installation, one installed prior to TAB work specified in Section 230593, one installed after final flush out, and one delivered to the Owner at Substantial Completion. Label filter boxes with equipment numbers as included in the equipment schedules on the Drawings.

PART 2 - PRODUCTS

2.1 REPLACEABLE PRE-FILTERS **AND** FILTERS

A. Pleated Media Type: Extended surface with reinforced non--woven cotton fabric in self--supporting frame, MERV 8 per ASHRAE 52.2, 2 as evaluated under Appendix J, 2 inch thick, UL 900.

B. Manufacturers: Camfil 30/30, AAF International, Flanders® Corporation, or approved.

2.2 FINAL FILTERS

A. Pleated Media Cartridge Type: Cartridges sealed in a galvanized steel frame with diagonal support members on both air entering and discharge sides, contour stabilizers for filter media and media support grids, filter media bonded to welded wire grid, MERV 13 per ASHRAE 52.2 as evaluated under Appendix J, 4 inch thick, UL 900.

B. Manufacturers: Camfil Riga--Flo Series, AAF International, Flanders® Corporation, or approved.

2.3 FILTER HOUSINGS AND FRAMES

A. For Air Handling Equipment: Filter housings and frames furnished by air handling equipment manufacturer and integral to air handling equipment unless otherwise indicated on the Drawings. Air handling equipment filter frames sized for filter media as specified in this section and as indicated on the Drawings. Filter access through hinged side servicing access doors with sash locks or rear access where space is available.

B. Side Servicing Access:

1. General: Factory fabricated and assembled, 16 gage galvanized steel housing and frames, reinforced corners, access doors on each side, with sponge neoprene peripheral gasket, maximum leakage 1 percent at 3 inch w.g.
2. Dimensions: Size for filter media with pre-filter as specified in this Section and as indicated on the Drawings.

3. Manufacturers: Camfil 4P Glide/Pack, AAF International, Flanders® Corporation, or approved.

2.4 RESISTANCE INDICATOR

A. General: Diaphragm--actuated dial type, 4-3/4 inch outside diameter with white dial, black figures and graduations, and pointer zero adjustment, 0 to 1 inch w.g. range with 0.05 inch minor division. Accuracy plus or minus 2 percent of full scale at 70 F. Include bracket, static pressure taps, aluminum tubing, and vent valves. Manufacturer: Dwyer® Magnehelic® Model 2001 or approved.

2.5 FILTERS DURING CONSTRUCTION

A. General: Pleated media type with reinforced synthetic blend filter media that has been electrostatically charged, MERV 8 per ASHRAE 52.2, 1 inch thick, UL 900.

B. Manufacturers: Camfil Aeropleat IV+, Flanders® Corporation, or approved.

PART 3 - EXECUTION

3.1 INSPECTION

A. General: Verify installation conditions as satisfactory to receive the Work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

3.2 PREPARATION

A. Field Measurements: Field verify locations of new and existing work prior to commencing the Work of this section.

B. Protection: Protect surrounding areas and surfaces to preclude damage from the Work of this section.

3.3 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

A. General: Install, apply, erect, and perform the Work in accordance with Article “Quality Assurance” provisions, specifications, and manufacturer’s installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

B. Coordinate with ductwork and air moving equipment as necessary to interface installation of and access to filters.

C. Install filters in proper position to prevent passage of unfiltered air.

D. Install resistance indicator static pressure taps upstream and downstream of filters to indicate air pressure drop through air filter. Install indicator on outside of filter housing or filter plenum in accessible and readable position.

3.4 HVAC SYSTEMS TRAINING

A. Comply with requirements in Section 230810.

3.5 COMMISSIONING

A. Equipment and systems referenced in this section shall be commissioned per Section 230800. The Contractor has specific responsibilities for scheduling, coordination, test development, testing and documentation.

END OF SECTION 234100

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Description: The Work includes air cooled chillers and associated appurtenances.

B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to the Work in this section.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.

B. Codes and Standards:

1. Applicable energy code.
2. AHRI 550/590, Performance Rating of Water - Chilling Packages Using the Vapor Compression Cycle.
3. ASHRAE Standard 15, Safety Standard for Refrigeration Systems.
4. ASME BPVC, Boiler Pressure and Vessel Code, Section VIII, Division 01, Rules for Construction of Pressure Vessels.
5. NFPA 70, National Electrical Code.
6. UL 1995, Heating and Cooling Equipment. If unit is not UL approved, manufacturer shall, at no additional cost to the Owner, arrange for field inspection by an UL representative to verify conformance to UL standards. If necessary, perform modifications to unit to comply with UL as directed by the UL representative.

1.3 SUBMITTALS

A. Comply with requirements in Division 01 and Section 230500.

B. Product Data: Submit manufacturer’s technical product data and maintenance data for the following: Indicate accessories where required for complete system and installation instructions.

1. Air cooled chillers, scroll type.
2. Blank copy of start-up and test report forms.

C. Shop Drawings: Submit chiller control wiring diagram indicating factory and field installed wiring.

D. Test Reports:

1. Factory start-up and test reports.
2. Field start-up and test reports.

3. Submit completed copy of reports and include copy in the Operations and Maintenance Manual.

1.4 WARRANTY

A. Warrant chiller components in general for 2 years and 10 years for compressors after Substantial Completion date. Warranty shall cover material, labor, and travel time. Make available replacement within 48 hours of initial notification.

1.5 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Section 232113 – Hydronic Piping Systems: Flow switches.

PART 2 - PRODUCTS

2.1 AIR COOLED CHILLERS, SCROLL TYPE

A. Description: One piece water chiller with multiple hermetic scroll compressors, evaporator, condenser coil, condenser fans, expansion valves, starter, and controls. Factory assembled and run tested and shipped with full oil and refrigerant charges.

B. Ratings: UL listed and labeled, ARI 550/590, and local energy code.

C. Cabinet: Galvanized steel frame and panels. Baked enamel finish. Cabinet panels with access doors for service to operating components.

D. Compressors and Motors: Direct-drive, scroll type with suction gas cooled motor. Compressor with centrifugal oil pump, oil level sight glass, oil charging valve, and crankcase heater and mounted on vibration isolators.

E. Evaporator: Stainless steel brazed plate design. Designed and tested for 650 psig refrigerant side working pressure and 150 psig water side working pressure. 3/4 inch thick insulation with K value of 0.26 on shell. Thermostatically controlled electric heat tape for freeze protection to minus 20 F outside air temperature.

F. Refrigerant System and Capacity Modulation: Complete refrigerant charge with R-410a. Each circuit independent with minimum 2 compressors piped in parallel. Each circuit with liquid line solenoid valve, thermal expansion valve, filter drier, liquid line sight glass, moisture indicator and service valves. Stable operation to 50 percent of full design capacity.

G. Condenser Coil: Aluminum fins mechanically bonded to internally enhanced seamless copper tubes with integral subcooling circuit. Factory pressure and leak tested with air underwater to 650 psig air pressure.

H. Condenser Fans and Motors: Direct-drive, statically and dynamically balanced propeller fans. Vertical discharge. Motors with permanently lubricated ball bearings and with 3 phase thermal overload protection. Include galvanized steel fan guards.

I. Electrical and Controls:

1. Compressor contactors and unit controls, factory mounted and wired, housed in watertight NEMA 3R enclosure.
2. Unit controller suitable to control leaving chilled water temperature, automatic compressor sequencing, condenser fan sequencing, load limiting, and anti-cycle functions.
3. System safeties include high discharge pressure, low suction pressure, high pressure switch, and compressor motor protector to prevent damage due to high input current and thermal overload of windings.
4. Unit safeties include automatic reset of compressors due to low ambient temperature, low leaving chilled water temperature, under voltage, flow switch operation failure.
5. Factory installed leaving and entering chilled water temperature sensors.
6. Controls include auto/stop switch, leaving chilled water temperature setpoint adjustment, and temperature differential adjustment viewable on digital display.
7. Factory installed microprocessor based unit controller to control unit functions located in main control panel. Factory run tested. Digital display of control data functions with keypad. Equipped with on-board diagnostics for hardware, software, and interconnecting wiring.
8. Single point electrical connections for power and controls. Factory installed and wired with transformers for 115 V and 24 V single phase power connections for controls power and heat trace. Include transient voltage surge suppression for controls power.
9. Include communication interface with DDC system specified in Section 230900 to remotely monitor water chiller from an operator workstation.

    a. Include the following input capabilities by means of factory or field installed services:

        1) Chiller enable.
        2) Leaving chilled water temperature setpoint.
        3) Chiller mode.
        4) Compressor circuit enable/disable.
        5) Current limit setpoint.

    b. Include the following output capabilities by means of factory or field installed devices:

        1) Chiller status.
        2) Active chilled water setpoint.
        3) Leaving chilled water temperature.
        4) Entering chilled water temperature.
        5) Alarm descriptor.
        6) Average percent running load amps (RLA) (actual capacity).
        7) Active current limit setpoint.

J. Disconnect Switch: Unit mounted and wired non-fused switch with external handle located inside control panel.

K. Flow Switch: Field installed accessory, vapor proof, single pole, double throw, NEMA 4X, rated for minus 20 F to 250 F.

L. Low Ambient Cooling: Factory installed accessory to modulate condenser fan motor in response to unit head pressure to allow compressor operation to 0 F outdoor air temperature. Include condenser louvered enclosure panels.

M. Hot Gas Bypass: Factory installed accessory with solenoid valve and adjustable hot gas bypass valve on 1 refrigeration circuit.

N. Starter: Factory mounted and wired across-the-line type housed in weathertight enclosure.

O. Compressors Power Factor Correction Capacitors: Factory installed accessory for 0.90 to 0.95 power factor correction.

P. Compressor Acoustical Sound Blanket: Factory installed accessory for each compressor consisting of 1 layer of 5/8 inch thick textile fiber and 1 layer of 1/8 inch anti-vibrating material both enclosed by 2 sheets of temperature and UV resistant PVC.

Q. Provide with roof mounted isolation base with 2” spring deflection per specification requirements in Div 230548

R. Manufacturers: York® International YCAL, Trane®, Daikin, Petra Engineering Industries Co. Ltd, or approved.

2.2 SOURCE QUALITY CONTROL

A. Perform functional test of water chillers before shipping.

B. Factory performance test water chillers, before shipping, according to ARI 550/590.

PART 3 - EXECUTION

3.1 INSPECTION

A. General: Verify installation conditions as satisfactory to receive the Work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

3.2 PREPARATION

A. Field Measurements: Field verify locations of new and existing work prior to commencing the Work of this section.

B. Protection: Protect surrounding areas and surfaces to preclude damage from the Work of this section.

3.3 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

A. General: Install, apply, erect, and perform the Work in accordance with Article “Quality Assurance” provisions, specifications, and manufacturer’s installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

B. Coordinate required electrical and control installation work with Division 26 and Section 230900.

3.4 WORK PRIOR TO INSTALLATION

A. Equipment manufacturer’s authorized representative shall maintain personnel within a 50 mile radius of job site. Representative capable of troubleshooting chillers and faults. Representative also to maintain programming equipment necessary to make software changes.

1. Include 1 man day to meet with mechanical, electrical and control subcontractors and mechanical engineer at job site. Schedule this meeting within 1 week after equipment is delivered to final location at job site but prior to installation. Purpose is to assure that all parties understand what interconnections are required.
2. After equipment installation, include 1 man day to assist control and electrical subcontractors in the termination of interconnecting wires in chiller mounted control panels. This service shall also verify proper connection and polarity of wires.

3.5 INSTALLATION OF CHILLERS

A. General: Support chillers and piping separately so piping is not supported by chillers.

B. Comply with requirements in Section 230548 for vibration isolators and Section 230550 for seismic restraints.

C. Repair damaged condenser coil fins.

3.6 START-UP SERVICES

A. Equipment manufacturer’s authorized representative shall perform start-up services of chillers and related appurtenances. Services shall include a check of proper installation, system check-out, adjustment, and complete start-up. Start-up by the Contractor not acceptable.

B. Coordinate start-up services with chilled water system operation as specified in Division 01 and Section 230500 and TAB work specified in Section 230593.

C. Include minimum of 5 working days during which time include at least 2 observations each of morning programmed start-up, mid-day operation, and programmed night shut down to verify proper operation of controls relating to chiller operation.

3.7 HVAC SYSTEMS TRAINING

A. Comply with requirements in Section 230810.

B. Representative shall conduct two 4 hour training sessions to demonstrate that equipment operates as indicated in the Contract Documents and in accordance with manufacturer's recommendations. First session shall cover operation of chillers. Second session shall cover detailed system operation and trouble shooting. Give minimum one week notice prior to demonstration. Furnish instruments and personnel required to conduct demonstration.

C. Starting time (during any normal operating shift) of training sessions will be determined by the Owner to minimize overtime required for his maintenance personnel.

D. Demonstrate proper performance of operating and safety controls, as well as stable equipment performance over entire operating range to satisfaction of the Owner prior to Substantial Completion.

E. Include instruction session to identify locations of servicing points and required maintenance requirements to the Owner's personnel.

F. Include preliminary discussion and presentation of information from instruction manuals, with appropriate references to the Contract Documents, followed by tour explaining maintenance requirements, access methods, servicing and maintenance procedures, equipment cleaning procedures, control settings and available adjustments.

G. After 30 days of normal operation, schedule meeting with the Owner's maintenance personnel responsible for chiller operation and supplier's software technician to outline software changes to meet specific system requirements. Job specific software changes agreed upon at this meeting shall be made at no extra cost to the Owner.

3.8 COMMISSIONING

A. Equipment and systems referenced in this Section shall be commissioned per Section 230800. The Contractor has specific responsibilities for scheduling, coordination, test development, testing and documentation.

END OF SECTION 236420

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Description: The Work includes packaged HVAC equipment with mechanical cooling capabilities and associated appurtenances and refrigerant piping for ductless split heat pump and variable refrigerant flow (VRF) systems.

B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to the Work in this section.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.

B. Codes and Standards:

1. Applicable energy code.
2. AHRI 13256-1, Water-Source Heat Pumps-Testing and Rating for Performance-Part 1: Water-to-Air and Brine-to-Water Heat Pumps.
3. AMCA 210, Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating.
4. AHRI 210/240, Performance Rating of Unitary Air-Conditioning and Air Source Heat Pump Equipment.
5. AHRI 270, Sound Rating of Outdoor Unitary Equipment.
6. AHRI 340/360, Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment.
7. AHRI 390, Single Package Vertical Air-Conditioners and Heat Pumps.
8. ASCE 7, Minimum Design Loads For Buildings and other Structures.
9. ASTM B 117, Standard Practice for Operating Salt Spray (Fog) Apparatus.
10. MSS SP- 58, Pipe Hangers and Supports – Materials, Design, Manufacture, Selection, Application, and Installation.
11. MSS SP- 69, Pipe Hangers Supports – Selection and Application.
12. NFPA 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems.
13. UL 1995, Heating and Cooling Equipment.

C. Refrigeration Piping Subcontractor Specified in Section 232300: Responsible for matching refrigeration equipment specified in this section, air handling equipment and their direct expansion cooling coils specified in Section 233400, and refrigeration piping and specialties specified in Section 232300.

1.3 SUBMITTALS

A. Comply with requirements in Division 01 and Section 230500.

B. Product Data: Submit manufacturer's technical product data and maintenance data for the following: Indicate accessories where required for complete system and installation instructions.

1. Variable refrigerant flow (VRF) split heat pump system, 6 through 36 tons.
2. Blank copy of start-up and test report forms.

C. Performance Data: Submit fan performance curve for unit. Indicate on separate graph for each fan, static pressure versus volume flow, efficiency, and brake horsepower, with scheduled design point shown and labeled. Performance certified in accordance with AMCA 210. A single fan curve not acceptable.

D. Shop Drawings: Submit packaged HVAC equipment control wiring diagram indicating factory and field installed wiring.

E. Test Reports:

1. Factory start-up and test reports.
2. Field start-up and test reports.
3. Submit completed copy of report and include copy in the Operations and Maintenance Manual.

1.4 WARRANTY

A. General: Warrant variable refrigerant flow (VRF) system components in general for 2 years and 6 years for compressors after Substantial Completion date. Warranty shall cover material, labor, and travel time. Make available replacement within 48 hours of initial notification.

1.5 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Section 230900 – Automatic Temperature Controls: Zone temperature sensors, thermostats, and similar control devices for packaged HVAC equipment.

PART 2 - PRODUCTS

2.1 VARIABLE REFRIGERANT FLOW (VRF) SPLIT HEAT PUMP SYSTEM 6 THROUGH 36 TON

A. Description: Variable capacity, heat recovery, heat pump system utilizing variable refrigerant flow and operating on R-410a. System consists of multiple evaporators (indoor units) using inverter driven outdoor unit. Outdoor unit with direct expansion (DX) air-cooled heat pump system with variable speed driven compressor. Heat recovery unit with tubing connections. Each indoor unit capable of operating separately with individual temperature control.

B. Outdoor Unit:

1. Description: Factory assembled, piped, and wired with electronic and refrigerant controls. Factory run tested. Designed to operate:

a. In Heating Mode: Down to minus 13 F outdoor air temperature and up to 61 F outdoor wet bulb temperature.
b. In Cooling Mode: Down to 14 F and up to 122 F outdoor air temperature.

2. Cabinet: Galvanized steel plate, bonderized with baked enamel finish.
3. Refrigerant Circuits Include refrigerant strainer, check valves, oil separator, accumulator, four way reversing valve, electronic expansion valves, high pressure and low pressure refrigerant charging ports, high pressure safety swith, service valves, interconnecting piping, and oil injection mechanism. Include subcooling heat exchanger.
4. Compressors: Two inverter controlled hermetic scroll compressors. Each compressor with crankcase heater, internal thermal overloads, and vibration isolators.
5. Unit Controls: Include control boards to operate VRF system and communicate in daisy chain configuration from outdoor unit to heat recovery unit to indoor units via 2 conductor, stranded and shielded cable for RS-485 communication.
6. Fan and Motor: Propeller type, vertical discharge, direct drive, variable speed fan motors. Motors with inherent protection and permanently lubricated bearings, variable speed, and fan guard.
7. Condenser Coil: Aluminum fins on copper tubing. Fins with corrosion resistant material with hydrophilic coating. Include integral metal guard.

C. Branch Distribution Unit:

1. Description: Factory assembled, internally piped, and wired with electronic and refrigerant controls. Factory run tested. Designed for indoor installation.
2. Cabinet: Galvanized steel, internally insulated.
3. Refrigerant Circuit: Y-branch kits, multiple ports to serve indoor units, each port with subcooling heat exchanger and two 2 position solenoid valves. Include tubing provisions for field furnished and installed isolation valves.
4. Unit Controls: Include control boards to operate VRF system and communicate in daisy chain configuration from outdoor unit and indoor units via 4 conductor, stranded and shielded cable for RS-485 communication.
5. Include microprocessors to communicate with main controller in outdoor unit.

D. Indoor Unit (Wall Mounted):

1. Description: Unit wall mounted type for installation within conditioned space connected to heat pump unit. Factory assembled and tested with wiring, piping, electronic expansion valve, control circuit board, fan and motor, condensate drain pan, self-diagnostic function and auto-restart functions. Include integral sensor within cabinet for use with wireless remote controller.
2. Cabinet: Affixed to factory supplied wall mounting back plate. Include manually adjustable airflow guide vane for units less than 15 Mbh and motorized sweeping airflow guide vane for units greater than 18 Mbh.
3. Fan and Motor: Direct drive, cross flow fan, statically and dynamically balanced, fan speed controlled using micrprocesser-dased DDC control for high speed for cooling “ON“ and low fan speed for cooling “OFF” and high speed fan for heating “ON” and fan off for heating “OFF”. Fan speeds adjustable between “LOW”, “MEDIUM”, and “HIGH”. Motor with permanently lubricated and sealed bearings. Fan/motor assembly mounted on rubber grommets
4. Filter: Removable, washable return air filter with anti-fungal treatment.
5. Coil: Direct expansion type constructed from copper tubes expanded into aluminum fins. Tubes with internal grooves, factory pressure tested and factory charged with dry

nitrogen. Include condensate pan below coil constructed of expanded polystyrene resin below coil with insulated flexible drain piping.

E. Indoor Unit (4-Way Ceiling Cassette):

1. Description: Unit recessed mounted type with 4-way discharge pattern connected to heat pump unit. Factory assembled and tested with wiring, piping, electronic expansion valve, control circuit board, fan and motor, condensate drain pan, self-diagnostic function and auto-restart functions. Include integral sensor within cabinet for use with wireless remote controller.
2. Cabinet: Include provisions for field installed outside air. Include filter grille on bottom of unit for 2-, 3-, or 4-way airflow.
3. Fan and Motor: Direct drive, cross flow fan, statically and dynamically balanced, fan speed controlled using micrprocesser-dased DDC control for high speed for cooling “ON“ and low fan speed for cooling “OFF” and high speed fan for heating “ON” and fan off for heating “OFF”. Fan speeds adjustable between “LOW”, “MEDIUM”, and “HIGH”. Motor with permanently lubricated and sealed bearings. Fan/motor assembly mounted on rubber grommets.
4. Filter: Removable, washable return air filter with anti-fungal treatment.
5. Coil: Direct expansion type constructed from copper tubes expanded into aluminum fins. Tubes with internal grooves, factory pressure tested and factory charged with dry nitrogen. Include condensate pan below coil constructed of expanded polystyrene resin below coil and condensate pump.

F. Indoor Unit (2-Way Ceiling Cassette):

1. Description: Unit recessed mounted type with 2-way discharge pattern connected to heat pump unit. Factory assembled and tested with wiring, piping, electronic expansion valve, control circuit board, fan and motor, condensate drain pan, self-diagnostic function and auto-restart functions. Include integral sensor within cabinet for use with wireless remote controller. Cabinet: Include provisions for field installed outside air. Include filter grille on bottom of unit for 2-way airflow. Fan and Motor: Direct drive, cross flow fan, statically and dynamically balanced, fan speed controlled using micrprocesser-dased DDC control for high speed for cooling “ON“ and low fan speed for cooling “OFF” and high speed fan for heating “ON” and fan off for heating “OFF”. Fan speeds adjustable between “LOW”, “MEDIUM”, and “HIGH”. Motor with permanently lubricated and sealed bearings. Fan/motor assembly mounted on rubber grommets.
2. Filter: Removable, washable return air filter with anti-fungal treatment.
3. Coil: Direct expansion type constructed from copper tubes expanded into aluminum fins. Tubes with internal grooves, factory pressure tested and factory charged with dry nitrogen. Include condensate pan below coil constructed of expanded polystyrene resin below coil and condensate pump.

G. Indoor Unit (1-Way Ceiling Cassette):

1. Description: Unit recessed mounted type with 2-way discharge pattern connected to heat pump unit. Factory assembled and tested with wiring, piping, electronic expansion valve, control circuit board, fan and motor, condensate drain pan, self-diagnostic function and auto-restart functions. Include integral sensor within cabinet for use with wireless remote controller.
2. Cabinet: Include provisions for field installed outside air. Include filter grille on bottom of unit for 1-way airflow.

3. Fan and Motor: Direct drive, cross flow fan, statically and dynamically balanced, fan speed controlled using micrprocesser-dased DDC control for high speed for cooling “ON“ and low fan speed for cooling “OFF” and high speed fan for heating “ON” and fan off for heating “OFF”. Fan speeds adjustable between “LOW”, “MEDIUM”, and “HIGH”. Motor with permanently lubricated and sealed bearings. Fan/motor assembly mounted on rubber grommets.
4. Filter: Removable, washable return air filter with anti-fungal treatment.
5. Coil: Direct expansion type constructed from copper tubes expanded into aluminum fins. Tubes with internal grooves, factory pressure tested and factory charged with dry nitrogen. Include condensate pan below coil constructed of expanded polystyrene resin below coil and condensate pump.

H. Indoor Unit (Fan Coil):

1. Description: Unit concealed type with inlet and outlet connections and connected to heat pump unit. Factory assembled and tested with wiring, piping, electronic expansion valve, control circuit board, fan and motor, condensate drain pan, self-diagnostic function and auto-restart functions. Include integral sensor within cabinet for use with wireless remote controller.
2. Cabinet: Include provisions for field installed outside air duct. Include inlet and outlet duct openings and filter opening.
3. Fan and Motor: Direct drive, cross flow fan, statically and dynamically balanced, fan speed controlled using micrprocesser-dased DDC control for high speed for cooling “ON“ and low fan speed for cooling “OFF” and high speed fan for heating “ON” and fan off for heating “OFF”. Fan speeds adjustable between “LOW”, “MEDIUM”, and “HIGH”. Motor with permanently lubricated and sealed bearings. Fan/motor assembly mounted on rubber grommets.
4. Filter: Removable, washable return air filter with anti-fungal treatment.
5. Coil: Direct expansion type constructed from copper tubes expanded into aluminum fins. Tubes with internal grooves, factory pressure tested and factory charged with dry nitrogen. Include condensate pan below coil constructed of expanded polystyrene resin below coil and condensate pump.

I. Manufacturers: LG Electronics Multi V™ IV Series, Daikin or approved.

2.2 REFRIGERANT PIPING FOR DUCTLESS SPLIT HEAT PUMP AND VRF SYSTEMS

A. Pipe: Copper, Type ACR soft drawn, pre-charged, ASTM B 280, cleaned and dehydrated for refrigeration service with ends capped and sealed, 700 psig working pressure rating. Mueller Streamline® Co. or approved.

B. Insulation: Closed cell elastomeric foam, factory pre-insulated, 1 inch thickness, meeting ASTM C 534 and ASTM E 84, UL listed and labeled with flame spread rating not greater than 25 and smoke developed rating not greater than 50.

C. Ball Valves: Full port, two piece forged brass body with Teflon® ball seals and copper tube extensions, brass **[**bonnet and**]** seal cap, chrome plated ball, stem with neoprene ring stem seals. Include Schrader ports. Maximum working pressure 500 psig and maximum temperature 300 F. Superior Valve Company, Parker Hannifin Corporation, Henry Technologies, or approved.

D. Pipe Supports: Fabricated sheet metal pan as indicated on the Drawings.

2.3 SOURCE QUALITY CONTROL

A. Perform function test of packaged HVAC equipment before shipping.

PART 3 - EXECUTION

3.1 INSPECTION

A. General: Verify installation conditions as satisfactory to receive the Work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

3.2 PREPARATION

A. Field Measurements: Field verify locations of new and existing work prior to commencing the Work of this section.

B. Protection: Protect surrounding areas and surfaces to preclude damage from the Work of this section.

3.3 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

A. General: Install, apply, erect, and perform the Work in accordance with Article “Quality Assurance” provisions, specifications, and manufacturer’s installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

B. Coordination: Coordinate required electrical and control installation work with Division 26 and Section 230900.

3.4 WORK PRIOR TO INSTALLATION

A. Equipment manufacturer’s authorized representative shall maintain personnel within 50 mile radius of job site. Representative capable of troubleshooting packaged HVAC equipment faults.

1. Include 1 man day to meet with mechanical, electrical and control subcontractors and mechanical engineer at job site. Schedule this meeting within 1 week after equipment is delivered to final location at job site but prior to equipment installation. Purpose is to ensure that all parties understand what interconnections are required.
2. After equipment installation, include 1 man day to assist control and electrical subcontractors in termination of interconnecting wires in unit mounted control panels. This service shall also verify proper connection and polarity of wires.

3.5 INSTALLATION OF PACKAGED HVAC EQUIPMENT AND COMPONENTS

A. Install equipment with clearances for service and maintenance.

B. Repair damaged condenser coil fins.

C. Coordinate with Division 26 to install disconnects so as not to interfere with unit and internal component access and filters.

D. Roof Mounted Equipment: Anchor to roof curbs shown on architectural drawings. Comply with requirements in Section 230548 for vibration isolators and Section 230550 for seismic restraints. Refer to architectural drawings for roof and roof insulation requirements.

3.6 INSTALLATION OF DUCTLESS VRF SYSTEMS

A. General: Install equipment level and plumb using manufacturer's standard mounting devices.

B. Install equipment with clearances for service and maintenance.

C. Install ball valves for zoned refrigerant isolation of each indoor unit and condensing unit.

D. Install pipe supports in accordance with MSS SP-58, MSS SP-69, and Section 232116, whichever is more stringent.

3.7 START-UP SERVICES

A. Equipment manufacturer's authorized representative shall perform start-up services of packaged HVAC equipment and related appurtenances. **[**Refrigeration subcontractor specified in Section 232300 shall perform start-up services for split systems and related appurtenances.**]** Services shall include check of proper installation, system check-out, adjustment, and complete start-up. Start-up by the Contractor not acceptable.

B. Coordinate start-up services with air distribution system operation as specified in Division 01 and Section 230500 and TAB work specified in Section 230593.

3.8 HVAC SYSTEMS TRAINING

A. Comply with requirements in Section 230810.

B. Representative shall conduct two 4 hour training sessions to demonstrate that equipment operates as indicated in the Contract Documents and in accordance with manufacturer's recommendations. First session shall cover operation of packaged HVAC equipment. Second session shall cover detailed system operation and trouble shooting. Give minimum one week notice prior to demonstration. Furnish instruments and personnel required to conduct demonstration.

C. Starting time (during any normal operating shift) of training sessions will be determined by the Owner to minimize overtime required for his maintenance personnel.

D. Demonstrate proper performance of operating and safety controls, as well as stable equipment performance over entire operating range to satisfaction of the Owner prior to Substantial Completion.

E. Include instruction session to identify locations of servicing points and required maintenance requirements to Owner's personnel.

F. Include preliminary discussion and presentation of information from instruction manuals, with appropriate references to the Contract Documents, followed by tour explaining maintenance requirements, access methods, servicing and maintenance procedures, equipment cleaning procedures, control settings and available adjustments.

3.9 COMMISSIONING

A. Equipment and systems referenced in this section shall be commissioned per Section 230800. The Contractor has specific responsibilities for scheduling, coordination, test development, testing and documentation.

END OF SECTION 238100

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes general electrical requirements for all Division 26, 27, and 28 work and is supplemental and in addition to the requirements of Division 01.

B. Section Includes:
1. Electrical equipment coordination and installation.
2. Sleeves for raceways and cables.
3. Sleeve seals.
4. Grout.
5. Common electrical installation requirements.

C. General Requirements: Conform to Contract Documents. This section is supplemental and in addition to requirements of Division 01.

D. Conditions and Requirements: Conditions and requirements of the General Provisions, Supplemental General provisions and Special Provisions are hereby made a part of the Electrical Division of this Specification. If requirements disagree, the more stringent requirement will become the contractual obligation.

E. Provide a complete working installation with all equipment called for in proper operating condition. Documents do not undertake to show or list every item to be provided. When an item not shown or specified is clearly necessary for proper operation of equipment shown or specified, provide an item which will allow the system to function at no increase in Contract Sum.

F. Workmanship shall be of the best quality and competent and experienced electricians shall be employed and shall be under the supervision of a competent and experienced foreman.

G. The drawings and specifications are complimentary and what is called for (or shown) in either is required to be provided as if called for in both.

1.2 DEFINITIONS

A. Definitions of all terms shall be in accordance with applicable definitions of:
1. AIA - American Institute of Architects
2. IEEE - Institute of Electrical and Electronic Engineers
3. IES - Illuminating Engineering Society
4. NEMA - National Electrical Manufacturers Association
5. NEC - National Electrical Code
6. IBC - International Building Code
7. IFC - International Fire Code
8. ADA - Americans with Disabilities Act
9. NFPA - National Fire Protection Association

1.3 CODES

A. Codes for installation of electrical work shall be State of Washington Electrical Code, Electrical Safety Code, applicable rules and regulations and OSHA and Washington Industrial Safety and Health Act. Any violation of the above Safety Codes shall be cause for immediate termination of Contractor's authority to proceed with work, and recourse to surety for completion of the project.

1.4 PERMITS AND INSPECTIONS

A. Obtain permits and pay fees required by governmental agencies having jurisdiction over this work.

B. Arrange for inspections required during construction. On completion of work, furnish satisfactory evidence to show all work installed in accordance with codes.

1.5 CLEARANCES

A. Adequate working space shall be provided around electrical equipment for maintenance and operation. Minimum clearances shall conform to Art. 110-16 of N.E. Code.

B. Coordinate clearances with all trades prior to installation.

1.6 TESTS

A. Test all wiring and connections for continuity and grounds before any fixtures or equipment are connected, and run a Megger test. Where such tests indicate faulty insulation or other defects, all such defects and faults shall be located, repaired and tested again.

B. Make check of proper load balance on 3-wire system and on phases of 3-phase system. Check direction of rotation and lubrication on all motors after final service connections have been made.

C. Make final tests in presence of Architect.

1.7 INDUSTRY STANDARDS, CODES AND SPECIFICATIONS

A. All materials, equipment, and systems shall conform to the following applicable Industry Standards, Codes and Specifications:
1. ANSI - American National Standards Institute
2. IEEE - Institute of Electrical and Electronic Engineers
3. IES - Illuminating Engineering Society
4. IPCEA - Insulated Power Cable Engineers Association
5. NFPA - National Fire Protection Association
6. NEMA - National Electrical Manufacturers Association
7. UL - Underwriters Laboratory
8. IBC - International Building Code
9. IFC - International Fire Code
10. IMC - International Mechanical Code

11. ADA - Americans with Disabilities Act (Washington State ADA)
12. WAC - Washington Administrative Code

B. Where differences occur between state laws, local ordinances, industry standards, utility company regulations and the Contract Documents, the most stringent shall govern.

1.8 QUALITY ASSURANCE

A. Regulatory Requirements:
1. Nothing in the Drawings or Specifications shall be construed to permit Work not conforming to applicable laws, ordinances, rules or regulations.
2. When Drawings or Specifications exceed requirements of applicable laws, ordinances, rules, or regulations, comply with documents establishing the more stringent requirements.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Ship equipment in its original package to prevent damage or entrance of foreign matter. Perform all handling and shipping in accordance with manufacturer's recommendations. Provide protective coverings during construction.

B. Identify materials and equipment delivered to the Site to permit check against approved materials list, and reviewed submittals.

1.10 PROJECT CONDITIONS

A. Equipment Rough-In:
1. Rough-in locations for equipment furnished under other Divisions and for equipment furnished by Owner are approximate only. Obtain exact rough-in locations from the following sources:
a. From Shop Drawings for Contractor provided equipment.
b. From Architect for Owner furnished, Contractor installed equipment.

1.11 MATERIAL AND EQUIPMENT ENVIRONMENT

A. All equipment and material shall be suitable for the environment of the installation, and the installation including equipment shall satisfy the governmental agencies having jurisdiction.

1.12 DRAWINGS AND SPECIFICATIONS

A. Specifications, with drawings, are intended to cover installation of all electrical equipment. Materials shown and called for on drawings, but not mentioned in specifications, or vice versa, necessary for proper completion and operation of equipment, shall be furnished the same as if called for in both.

B. Electrical drawings do not attempt to show complete details of project construction which affect electrical installations. Refer to architectural, structural and mechanical drawings for additional details which affect installation of this work.

1.13 COORDINATION

A. Coordinate arrangement, mounting, and support of electrical equipment:
   1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
   2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
   3. To allow right of way for piping and conduit installed at required slope.
   4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

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 electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

E. Before installation Contractor shall make proper provisions for electrical work and to avoid interferences with installation of other work. Any changes caused by neglect to do so shall be made at Contractor’s expense.

F. Electrical drawings and specifications shall be compared with drawings and specifications of other trades and any discrepancies between them reported to the Architect prior to installation of work.

G. Coordinate and arrange work so there is no interference between wiring outlets, lighting fixtures, and raceways with sheet metal work, insert hangers, mechanical piping, and structural members.

1.14 CUTTING AND PATCHING

A. Do all cutting and patching for installation of the work. All cutting done carefully to prevent damage to work of other trades, and all patching done by mechanics skilled in the trade affected, and subject to approval by Architect. Provide all work per Division 01. Work shall include:
   1. All openings for removed equipment shall be patched or entire system replaced. No openings shall remain at completion of work.
   2. Exterior cutting and patching shall be done by qualified Contractors. Patching of asphalt and concrete shall be per Division 01 and approved by Civil Engineers and Architect. Grass and earth patching, seeding, and sod work shall be per Division 01 and approved by the Landscaper, Civil Engineer, and Architect. All backfill per Division 01.
   3. Painting: All exposed conduit, boxes, surface metal raceway, enclosures, multi-outlet assemblies shall be painted to match wall color. Where exact color unknown, coordinate with Architect to obtain color. All items shall be painted regardless of whether wall, ceiling, floor finish is painted.

1.15 RUBBISH AND CLEAN-UP

A. Contractor shall promptly remove waste material and rubbish caused by workers.

B. At completion of work, clean all fixtures, electrical panel interiors, switchboards, distribution centers, and all other equipment installed.

1.16 SCOPE OF WORK

A. Mention herein or indication on drawings of articles, materials, operations or methods, requires that Contractor provide each item mentioned or indicated, of quality, or subject to qualifications noted; perform according to conditions stated, each operation prescribed.

B. Work included under this contract provides for all labor, equipment, and materials to complete all electrical work as outlined in drawings and specifications for project.

1.17 SUBMITTALS

A. General:
1. Submittals shall be in accordance with requirements of Division 01 and as specified.
2. Forward all submittals to the Architect, together, at one time. Individual or incomplete submittals are not acceptable.
3. Organize submittals in same sequence as they appear in Specification Sections.
4. Identify each submittal item by reference to Specification Section paragraph in which item is specified, or Drawing and Detail number.
5. Identify each item by manufacturer, brand, trade name, number, size, rating, or whatever other data is necessary to properly identify and review materials and equipment. Words ″as specified″ are not sufficient identification.

B. Shop Drawings:
1. Show physical arrangement, construction details, finishes, materials used in fabrication, provisions for conduit entrance, access requirements for installation and maintenance, physical size, electrical characteristics, foundation and support details, and weights.
2. Catalog cuts and published material may be included to supplement Shop Drawings.

C. Contract Closeout Submittals:
1. Provide full size copies of ″Record″ one-line diagrams, in metal frames with glass fronts. Locate diagrams as directed.
2. Operation and Maintenance:
   a. Subsequent to final completion, and testing operations, instruct Owner’s authorized representatives in operation, adjustment, and maintenance of electrical plant.
   b. Before Owner’s personnel assume operation of systems, submit operating and maintenance instructions, manuals, parts lists on electrical plant, its component parts, including all equipment which requires, or for which the manufacturer recommends, maintenance in a specified manner. Data sheets shall show complete internal electrical wiring, ratings, and characteristics, catalog data on components parts whether furnished by equipment manufacturer or others, names, addresses, and telephone numbers of source of supply for parts subject to wear or electrical failure, and description of operating, test, adjustment, and maintenance procedures.

D. Submit the equipment to the Architect for final review.

1.18 ELECTRICAL EQUIPMENT MAINTENANCE MANUALS

A. The Electrical Contractor shall prepare maintenance manuals for the servicing of all equipment installed as a part of the construction contract.

B. The information contained in the manuals shall be grouped in an orderly arrangement under basic categories, i.e., Secondary Systems Equipment, Special Raceways, Motors & Controls, Lighting Equipment, etc.

C. Bind in 3-ring binder with label clearly indicating project.

1.19 JOB RECORD INFORMATION

A. Record drawings shall be continuously maintained in the field by the Contractor. Drawings used for this purpose shall be the latest revision and shall be kept neat and clean.

B. Drawings shall include dimensions on all underground conduit.

1.20 NAMEPLATES AND TAGS – SEE 260553

A. The following items shall be equipped with tags or nameplates with etched letters:
   1. All motors, transformers, motor starters, pushbutton stations, control panels and time switches.
   2. Disconnect switches, fused or unfused; switchboards and panelboards; circuit breakers, contactors or relays in separate enclosures.
   3. Wall switches controlling outlets, or equipment where the outlets are not located within sight of the controlling switch. All low voltage lighting switches.
   4. Special electrical systems shall be properly identified at junction and pull boxes, terminal cabinets and equipment racks.
   5. Label all junction boxes with pen indicating type of system (i.e. Power, Data, etc.), circuit voltage, panel and circuit number and switch leg.
   6. Paint all junction boxes per 26053-2,7.
   7. Label all data and telephone outlets and patch panels with manufacturer’s labels. Labels per the owner.

1.21 FINAL SUBMITTALS

A. After completion of all electrical work and prior to final inspection, submit the following:
   1. Letter addressed to Engineer, stating that Contractor, or superintendent in charge of job, has personally made a complete inspection of the job; that those items found to be defective in material or workmanship or not in conformance with drawings and specifications have been corrected; and that entire electrical job is ready for final observation by Engineer.
   2. One copy of the electrical equipment maintenance manual (see 1.15) to be sent direct to Engineer for review, containing the following:
      a. Letter of transmittal, addressed to Engineer, containing a list of suppliers of replacement parts for all electrical equipment used on job.

b. Panel, switchboard, and control drawings corrected to agree with Engineer's notations.
c. Catalog cuts of all lighting fixtures, lamps, transformers, starters, special devices, door control system, and all other equipment used on job.
d. All available maintenance data published.
e. Wiring diagrams and operating instructions for all systems installed.
f. Marked-up set of prints showing exact location of all conduits and outlets deviating from original plans. Purchase prints new for this purpose. Prints not required to be bound in maintenance manual.
g. Signed receipts for all loose items i.e. keys, instructions and guarantee, etc.

3. Refer to Division 01 for Operations and Maintenance Manuals.

1.22 WARRANTY

A. Warranties shall be provided per Division 01. Where not indicated provide minimum 1 year (or standard manufacturers warranty if longer) warranty for all equipment installed on this project. Warranty shall include all labor, site visit, installation costs.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials and Equipment General Requirements:
1. All items of materials in each category of equipment shall be of one manufacturer.
2. Groups of items having same or similar function shall be by single manufacturer to facilitate maintenance and service.
3. Compatible with space allocated. Modifications necessary to adjust items to space limitations shall be at Contractor's expense.
4. Conform with conditions shown and specified. Coordinate with other trades for best possible assembly of completed Work.
5. Install fully operating without objectionable noise or vibration.

B. Access Doors:
1. Furnish under this Division where shown, required by regulatory agencies, and for access to all concealed electrical items requiring access. Access doors shall be in accordance with requirements of Division 08. Doors in this Division, Division 08, and Division 15 shall be from the same manufacturer for identical appearance and keying. Furnish fire rated doors where required. Deliver access doors for installation under Division 08. Mark each access door to accurately establish its location.

C. Firestopping and Smokestopping: Provide in accordance with Division 07.
1. Provide firestopping where wiring, conduit, or cable tray penetrates fire wall or floor.
2. Provide smokestopping where wiring, conduit, or cable tray penetrates smoke barrier.

2.2 SLEEVES FOR RACEWAYS AND CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel.
   1. Minimum Metal Thickness:
      a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side more than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
      b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches (1270 mm) and 1 or more sides equal to, or more than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.3 SLEEVE SEALS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable
   1. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
      a. Advance Products & Systems, Inc.
      b. Calpico, Inc.
      c. Metraflex Co.
      d. Pipeline Seal and Insulator, Inc.
   2. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
   3. Pressure Plates: Plastic, Carbon steel. Include two for each sealing element.
   4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.4 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Follow manufacturer’s directions in all cases where manufacturers of articles used furnish directions covering points not shown or specified.

B. Accurately set and level equipment with supports neatly placed and properly fastened. No allowance of any kind will be made for negligence on the part of the Contractor to foresee means of bringing in and installing equipment in position inside the building.

C. Conduit System:
   1. Work into complete integrated arrangement with like elements. Make Work neat and finished appearing.

2. Run concealed, except where shown otherwise. Where exposed run parallel with walls or structural elements with vertical runs plumb, horizontal runs level; groups racked together neatly with bends parallel and uniformly spaced.
3. Flash and counterflash all penetrations through roof in accordance with requirements of Division 07 and as shown.

D. Provide hangers, supports, anchors and chases as required for installation of Electrical Work.

E. Excavating and Backfilling: In accordance with requirements of Division 02. Provide all necessary shoring, sheeting, and pumping as part of Work of this Division.

F. Concrete: In accordance with requirements of Division 3. All concrete encased electrical ductbanks shall have red concrete.

G. Interface with other products:
1. For purposes of clarity and legibility, Drawings are essentially diagrammatic to the extent that many offsets, bends, special fittings, and exact locations of items are not indicated, unless specifically dimensioned. Exact routing of wiring, and locations of outlets, panels, and other items shall be governed by structural conditions or obstructions. Contractor shall make use of data in Contract Documents. In addition, Architect reserves right, at no increase in Contract Sum, to make any reasonable change in location of electrical items exposed at ceilings or on partitions to group them in orderly relationships or to increase their utility. Verify requirements in this regard prior to roughing-in.
2. Take dimensions, location of doors, partitions, and similar features from Architectural Drawings. Verify at the Site under this Division. Consult Architectural Drawings for exact location of outlets, and other items to center with architectural features. Coordinate location of all ceiling mounted items with Division 09.

3.2 FIELD QUALITY CONTROL

A. Test panels and circuits for grounds and shorts with mains disconnected from feeders, branch circuits connected, and circuit breakers closed, all fixtures in place, permanently connected, grounding jumper to neutral lifted, and with all wall switches closed.

3.3 CLEANING

A. Properly prepare Work under this Division to be finish painted under Division 01.

3.4 EQUIPMENT IDENTIFICATION

A. Properly identify panelboards, circuit breakers in panelboards, disconnect switches, starters, and other apparatus used for operation or control of circuits, appliances or equipment.

3.5 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity

E. Right of Way: Give to piping systems installed at a required slope.

3.6 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both surfaces of walls.

F. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level.

G. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable, unless indicated otherwise.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry
   1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants.".

J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."

K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

3.7 SLEEVE-SEAL INSTALLATION

A. Install to seal exterior wall penetrations

B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.8 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

3.9 DEMOLITION AND REMODEL

A. Remove all electrical installation as indicated on drawings and required for operations. All salvage shall be presented to the Owner for review and Owner rejected equipment shall become the property of the Contractor and removed from the site. Owner retained equipment shall be delivered to the Owner at a designated location.

B. Retain all existing systems where shown on drawings or as required for systems operation.

C. Demolition drawings show areas to be demolished and do not show removal of individual devices, concealed items or circuits and raceways. Contractor shall remove all devices and equipment, non-reused raceway, raceway above accessible ceilings, on roofs, and other areas. Completely concealed or buried circuits may have wire removed, be capped and abandoned. Boxes shall be completely removed not simply covered. All areas shall be patched (see previous paragraph). All areas where equipment removed shall be painted. All cable shall be removed from abandoned circuits. Retain certain equipment as noted on drawings.

D. Acceptable to reuse existing conduits where shown on drawing and in suitable condition as accepted by architect. Provide new conduit where existing is unsuitable. Existing raceway may be used only when route does not conflict with access or any other trades. Existing wire may not be reused except where explicitly shown.

E. Schedule down times of partial areas and systems with Architect to suit Owner's convenience per Division 01. All power shutdown work shall be scheduled with minimum 2 weeks notice and be done on Saturday and Sunday. No more than a branch panel shall be permitted for these types of shutdowns. All main power shutdowns are per A above.

F. Relocate and/or revise existing wiring and systems as required for operations during construction. All systems shall remain operational. Work shown on drawings does not necessarily show all work to accommodate as record drawings do not show circuitry. Contractor shall include time to as-built existing systems and route circuitry and systems around demolition areas prior to demolishing any work in the area. Contractor shall coordinate with all other trades as to phasing, means and methods, and timing and provide a comprehensive plan, including all temporary circuits required to keep the building fully operational.

G. Maintain existing fire alarm, telephone, intercom, clock, television, intrusion alarm, Data/voice, and Wide Area Network, at all times except as scheduled with the Architect. (School will be occupied throughout project.). Where remodeling work disrupts continuity of existing circuits or systems to remain, restore same at no additional cost to Owner.

H. Remove all existing communications cables not remaining in service completely.

END OF SECTION 260500

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Building wires and cables rated 600 V and less.
   2. Connectors, splices, and terminations rated 600 V and less.
   3. Sleeves and sleeve seals for cables.

1.2 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Qualification Data: For testing agency.

C. Field quality-control test reports.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

1.5 COORDINATION

A. Set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Alcan Products Corporation; Alcan Cable Division.
   2. American Insulated Wire Corp.; a Leviton Company.
   3. General Cable Corporation.
   4. Senator Wire & Cable Company.
   5. Southwire Company.

C. Copper Conductors: Comply with NEMA WC 70. Minimum size - No. 12 AWG. Stranded

D. Aluminum: Stabloy type in sizes No. 2 and larger only. Burndy Hy-lug or Hy-plug terminations.

E. Conductor Insulation: Comply with NEMA WC 70. Drawings are based on using THHN-THWN copper cables. Contractor shall increase conduit size for any other insulation or if aluminum used.

F. Ground Wire: Proved THWN ground wire in all circuits, sized per code. Raceway shall not be used as ground.

G. Control and Low Voltage Cable: Cable shall be as recommended by manufacturer. Contractor shall coordinate location of plenums in building with all other trades. Provide plenum rated cable whenever cable passes through a plenum for the entire length. Building is a VAV return air plenum. Any cable in plenum areas shall be plenum rated.

2.2 CONNECTORS AND SPLICES

A. Splices and Terminations
   1. 600 Volt
      a. Splices: Solderless type only. Preinsulated "twist-on" type permitted on solid conductor size number 10 and smaller. Hydraulic compression long barrel type with application preformed insulated cover, heat shrinkable tubing or plastic insulated tape for all stranded conductors. For stranded conductors provide terminations designed for use with stranded conductors.
      b. Terminations: 250 kcmil and above - two hole long barrel compression lugs. Below 250 kcmil - single hole compression lug. Conductors No. 12 and smaller: provide eye or forked tongue compression lugs at bolted or screw connections - no lugs required for compression style terminal blocks.
      c. Cable Ties: Nylon or accepted, locking type. Use a torque limiting tool for installation of ties.
   2. Control Cable Splices and Terminations
      a. Splices: Preinsulated crimp pigtail or butt splice connectors.
      b. Terminations: Locking spade, insulated, compression lugs.

B. Splices and Terminations When Aluminum Wire Permitted (See Part 3)
   1. Burndy Hy-Lug or Hy-Plug on both ends.

C. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AFC Cable Systems, Inc.
   2. Hubbell Power Systems, Inc.
   3. O-Z/Gedney; EGS Electrical Group LLC.
   4. 3M; Electrical Products Division.
   5. Tyco Electronics Corp.

D. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Submit schedule of proposed aluminum wire for review. Contractor to increase conduit size to accommodate aluminum wire.

B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

C. Minimum wire size: No. 12 AWG.

D. All raceways sized based on THHN/THWN. Contractor shall increase conduit size when alternate insulation used.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Type THHN-THWN, single conductors in raceway. All raceways sized based on THHN/THWN. Contractor shall increase raceway size when alternate insulation used.

B. Branch Circuits: Type THHN-THWN, single conductors in raceway.

C. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

D. Class 1 Control Circuits: Type THHN-THWN, in raceway.

E. Class 2 Control and Low Voltage Circuits: Type THHN-THWN, in raceway, or as required by manufacturer. Plenum rated where required. Cable shall not be installed in slab or under ground. All circuits shall be installed in raceway when installed in walls and non-accessible spaces.

3.3 BRANCH WIRING

A. General: Complete system of conduit required to all light outlets, receptacles, switches, etc. as shown. Conduit size as shown on drawings, except where no size is shown, conduit shall be sized per National Electrical Code. No conduit shall carry more than 8 conductors. All exposed switches, receptacles or outlet boxes for other purposes, install die cast boxes, except where specifically noted otherwise. Feeder cables shall have each phase identified according to the established code.

B. Coding: Branch circuit color code shall be: For 120/208 V. Black – Phase A, Red – Phase B, Blue – Phase C, White – Neutral, Green – Ground, Isolated Ground – Green with Yellow stripe, Purple “Travellers” on 3 and 4 way switching. For 277/480V. Brown (A), Orange (B), Yellow

(C), and Gray neutral. Where colors are not available (No. 4 and larger both on the wire. Phase and neutral wires shall appear in the same position and rotation at all appearances.

3.4 EQUIPMENT WIRING

A. General: Wiring connections for power and control for all equipment shall be complete including disconnect switches and controls unless otherwise specified or noted on drawings.

B. Control wiring for mechanical systems installed under this section of specifications shall be in accordance with mechanical drawings and specifications.

3.5 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in raceway in finished walls, ceilings, and floors, unless otherwise indicated.

B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

D. Exposed cables not permitted.

E. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."

F. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."

3.6 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
   1. Use oxide inhibitor in each splice and tap conductor for aluminum conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches (300 mm) of slack.

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:
   1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors, and branch conductors for compliance with requirements.

a. Megger Test

2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
3. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in cables and conductors No. 2 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner.
   a. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
   b. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

C. Test Reports: Prepare a written report to record the following:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

D. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 260519

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes methods and materials for grounding.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Operation and Maintenance Data: For grounding to include the following in emergency, operation, and maintenance manuals:
   1. Instructions for periodic testing and inspection of grounding features at test wells, ground rings, grounding connections for separately derived systems, based on NFPA 70B.
      a. Tests shall be to determine if ground resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if they do not.
      b. Include recommended testing intervals.

1.3 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
   1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association to supervise on-site testing specified in Part 3.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:
   1. Solid Conductors: ASTM B 3.
   2. Stranded Conductors: ASTM B 8.
   3. Tinned Conductors: ASTM B 33.
   4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter.

5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

C. Grounding Bus: Rectangular bars of annealed copper, 1/4 by 2 inches (6 by 50 mm) in cross section, unless otherwise indicated; with insulators.

2.2 CONNECTORS

A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.
1. Pipe Connectors: Clamp type, sized for pipe.

C. Insulated Ground Conductors: Per 260519.

D. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.3 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel; 3/4 inch by10 feet (19 mm by 3 m) in diameter or as required by code authority.

B. Chemical-Enhanced Grounding Electrodes: Copper tube, straight or L-shaped, charged with nonhazardous electrolytic chemical salts.
1. Termination: Factory-attached No. 4/0 AWG bare conductor at least 48 inches (1200 mm) long.
2. Backfill Material: Electrode manufacturer's recommended material.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 10 AWG and smaller, and stranded conductors for No. 8 AWG and larger, unless otherwise indicated.

B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 3/0 AWG minimum.
1. Bury at least 24 inches (600 mm) below grade.
2. Duct-Bank Grounding Conductor: Bury 12 inches (300 mm) above duct bank when indicated as part of duct-bank installation.

C. Ground Conductors: Green colored insulation. Provide in all raceways.

D. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.

E. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
   1. Install bus on insulated spacers 1 inch (25 mm), minimum, from wall 6 inches (150 mm) above finished floor, unless otherwise indicated.
   2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, down to specified height above floor, and connect to horizontal bus.

F. Conductor Terminations and Connections:
   1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors or exothermic weld where required by code authority.
   2. Underground Connections: Welded connectors, except at test wells and as otherwise indicated.
   3. Connections to Ground Rods at Test Wells: Bolted connectors.
   4. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2 grounding requirements.

B. Grounding Manholes and Handholes: Ground manhole or handhole floor, close to wall to ground conductor per WAC requirements. Ground rods acceptable on communications handhole.

C. Other systems: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches (100 mm) will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches (50 mm) above to 6 inches (150 mm) below concrete. Seal floor opening with waterproof, nonshrink grout.

D. Grounding Connections to Handhole/Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.

3.3 GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
   1. Feeders and branch circuits.
   2. Lighting circuits.
   3. Receptacle circuits.

4. Single-phase motor and appliance branch circuits.
5. Three-phase motor and appliance branch circuits.
6. Flexible raceway runs.
7. Armored and metal-clad cable runs.
8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
9. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.

C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

D. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

E. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

F. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

G. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-2-by-12-inch (6-by-50-by-300-mm) grounding bus.
2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

3.4 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground Rods: Drive rods until tops are 2 inches (50 mm) below finished floor or final grade, unless otherwise indicated.
1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.

2. For grounding electrode system, install at least four (4) rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

C. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Division 26 Section "Underground Ducts and Raceways for Electrical Systems," and shall be at least 12 inches (300 mm) deep, with cover.
1. Test Wells: Install at least one test well for each service, unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

D. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.

E. Grounding and Bonding for Piping:
1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

F. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners.

G. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70, using a minimum of 20 feet (6 m) of bare copper conductor not smaller than No. 3/0 AWG.
1. If concrete foundation is less than 20 feet (6 m) long, coil excess conductor within base of foundation.
2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building grounding grid or to grounding electrode external to concrete.

H. Separately Derived Systems (Transformers): Bond to structural steel, main waterpipe within five feet of waterpipe entry to building, or building grounding electrode.

I. Consult with code authority and comply with all code authority requirements.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:

B. Perform the following tests and inspections and prepare test reports:
   1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
   2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells, and at individual ground rods. Make tests at ground rods before any conductors are connected.
      a. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
      b. Perform tests by fall-of-potential method according to IEEE 81.

C. Report measured ground resistances that exceed the following values:
   1. Power and Lighting Equipment or System with Capacity 500 kVA and Less: 10 ohms.
   2. Power and Lighting Equipment or System with Capacity 500 to 1000 kVA: 5 ohms.
   3. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohm(s).

D. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 260526

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Hangers and supports for electrical equipment and systems.
   2. Construction requirements for concrete bases.

B. Related Sections include the following:
   1. Division 26 Section "Vibration And Seismic Controls For Electrical Systems" for products and installation requirements necessary for compliance with seismic criteria.

1.2 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. IMC: Intermediate metal conduit.

C. RMC: Rigid metal conduit.

D. IBC: International Building Code

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

E. All supports shall comply with IBC, Washington Seismic Zone, Building Use Group III.

1.4 SUBMITTALS

A. Product Data: For the following:
   1. Steel slotted support systems.
   2. Nonmetallic slotted support systems.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
   1. Trapeze hangers. Include Product Data for components.
   2. Steel slotted channel systems. Include Product Data for components.
   3. Nonmetallic slotted channel systems. Include Product Data for components.
   4. Equipment supports.

C. Welding certificates.

1.5 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Comply with NFPA 70.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Allied Tube & Conduit.
      b. Cooper B-Line, Inc.; a division of Cooper Industries.
      c. ERICO International Corporation.
      d. GS Metals Corp.
      e. Thomas & Betts Corporation.
      f. Unistrut; Tyco International, Ltd.
      g. Wesanco, Inc.
   2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
   3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
   4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
   5. Channel Dimensions: Selected for applicable load criteria.

B. Nonmetallic Slotted Support Systems: Not permitted.

C. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

D. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
   1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         1) Hilti Inc.
         2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
         3) MKT Fastening, LLC.
         4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
   2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         1) Cooper B-Line, Inc.; a division of Cooper Industries.
         2) Empire Tool and Manufacturing Co., Inc.
         3) Hilti Inc.
         4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
         5) MKT Fastening, LLC.
   3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
   4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
   5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
   6. Toggle Bolts: All-steel springhead type.
   7. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slottedsupport system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
   1. Secure raceways and cables to the supports.

D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT may be supported by openings through structure members, as permitted in NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
   1. To Wood: Fasten with lag screws or through bolts.
   2. To New Concrete: Bolt to concrete inserts.
   3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
   4. To Existing Concrete: Expansion anchor fasteners.
   5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
   6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.
   7. To Light Steel: Sheet metal screws.
   8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES (HOUSEKEEPING PADS)

A. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section.

C. Anchor equipment to concrete base.
1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).

B. Touchup: Comply with requirements in Division 09 for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 260529

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. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. ENT: Electrical nonmetallic tubing.

C. EPDM: Ethylene-propylene-diene terpolymer rubber.

D. FMC: Flexible metal conduit.

E. IMC: Intermediate metal conduit.

F. LFMC: Liquidtight flexible metal conduit.

G. LFNC: Liquidtight flexible nonmetallic conduit.

H. NBR: Acrylonitrile-butadiene rubber.

I. RNC: Rigid nonmetallic conduit.

J. RGS: Rigid galvanized steel

K. PVC: Polyvinyl Chloride

L. MC: Metal Clad

1.4 SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Shop Drawings: For the following raceway components. Include plans, elevations, sections, details, and attachments to other work.
   1. Custom enclosures and cabinets.
   2. For handholes and boxes for underground wiring, including the following:
      a. Duct entry provisions, including locations and duct sizes.

b. Frame and cover design.
c. Grounding details.
d. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.
e. Joint details.

C. Manufacturer Seismic Qualification Certification: Submit when requested certification that enclosures and cabinets and their mounting provisions, including those for internal components, will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
a. The term "withstand" means "the cabinet or enclosure will remain in place without separation of any parts when subjected to the seismic forces specified."
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 METALLIC CONDUIT AND TUBING

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. AFC Cable Systems, Inc.
2. Alflex Inc.
3. Allied Tube & Conduit; a Tyco International Ltd. Co.
4. Anamet Electrical, Inc.; Anaconda Metal Hose.
5. Electri-Flex Co.
6. Manhattan/CDT/Cole-Flex.
7. Maverick Tube Corporation.
8. O-Z Gedney; a unit of General Signal.
9. Wheatland Tube Company.

B. Rigid Steel Conduit: ANSI C80.1.

C. Aluminum Rigid Conduit: Not permitted.

D. IMC: ANSI C80.6.

E. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
1. Comply with NEMA RN 1.

2. Coating Thickness: 0.040 inch (1 mm), minimum.

F. EMT: ANSI C80.3. Hot dipped galvanized inside and outside.

G. FMC: Steel

H. LFMC: Flexible steel conduit with PVC jacket.

I. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.
1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
2. Fittings for EMT: Steel, compression only for wet/damp locations. Provide stell set screw type for interior and dry areas.
3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.

J. Joint Compound for Rigid Steel Conduit or IMC: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

2.2 NONMETALLIC CONDUIT AND TUBING

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. AFC Cable Systems, Inc.
2. Anamet Electrical, Inc.; Anaconda Metal Hose.
3. Arnco Corporation.
4. CANTEX Inc.
5. CertainTeed Corp.; Pipe & Plastics Group.
6. Condux International, Inc.
7. ElecSYS, Inc.
8. Electri-Flex Co.
9. Lamson & Sessions; Carlon Electrical Products.
10. Manhattan/CDT/Cole-Flex.
11. RACO; a Hubbell Company.
12. Thomas & Betts Corporation.

B. ENT: NEMA TC 13. Not permitted except for fiber optic cable innerduct in raceway.

C. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated as PVC 80. Incoming telephone and TV circuits shall be PVC–80.

D. LFNC: Not permitted.

E. Fittings for ENT and RNC: NEMA TC 3; match to conduit or tubing type and material.

F. Fittings for LFNC: Not permitted.

2.3 MC CABLE

A. Conductors are made from class B copper. Sizes 12 awg and 10 awg may be either solid or stranded. The conductors are constructed with THHN/THWN or XHHW-2 insulation rated for 90oC dry at 600 volts max. Copper grounding conductors are cabled with the phase conductors. In circuit applications, the grounding conductor size is based on the rating of the over-current device. An additional grounding conductor is provided for isolated or redundant grounding.

2.4 METAL WIREWAYS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cooper B-Line, Inc.
2. Hoffman.
3. Square D; Schneider Electric.

B. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1 or 3R when outside, unless otherwise indicated.

C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Hinged type.

E. Finish: Manufacturer's standard enamel finish.

2.5 SURFACE RACEWAYS

A. Surface Metal Raceways: Galvanized steel with snap-on covers. Manufacturer's standard enamel finish in color selected by Architect. Only acceptable where specifically approved by architect
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
a. Wiremold Company.
2. Wiremold 700 minimum size.
3. Wiremold 2100 minimum size for communications circuits.

B. See wiring devices for multi-outlet assembly.

2.6 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
2. EGS/Appleton Electric.
3. Erickson Electrical Equipment Company.
4. Hoffman.
5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.

6. O-Z/Gedney; a unit of General Signal.
7. RACO; a Hubbell Company.
8. Robroy Industries, Inc.; Enclosure Division.
9. Scott Fetzer Co.; Adalet Division.
10. Spring City Electrical Manufacturing Company.
11. Thomas & Betts Corporation.
12. Walker Systems, Inc.; Wiremold Company (The).
13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.

B. Sheet Metal Outlet and Device Boxes: NEMA OS 1. Minimum size: 4-inch by 4-inch by 1 ½-inch. Voice/data boxes minimum 2 1/8-inch deep.

C. Except in unfinished areas such as mechanical and electrical rooms, outlet, junction and pull boxes in new construction shall be flush mounted to the finished surface. Provide raised trim rings as required to insure device will be flush with finished surface.

D. Outlet, junction and pull boxes in existing construction shall be concealed by cutting in to existing partition and fishing flex from above suspended ceilings. Where outlet, junction and pull boxes cannot be concealed, use of surface mounted outlet, junction and pull boxes and associated raceway system must be reviewed with the District prior to use. (Note: The district expects surface mounted raceway will be required in many locations in existing classrooms and hallways. It will be the designer's responsibility to determine where surface raceway is appropriate and advise the District accordingly. Issue of cost/benefit will need to be reviewed.) Size J boxes so no extension boxes are needed

E. Provide raised trim rings as required to insure devices will be flush with finished surface.

F. Cast-Metal Outlet and Device Boxes: NEMA FB 1, aluminum, Type FD, with gasketed cover.

G. Nonmetallic Outlet and Device Boxes: Not permitted.

H. Metal Floor Boxes: See 26 27 26.

I. Nonmetallic Floor Boxes: Not permitted.

J. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

K. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover.

L. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.
1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

M. Cabinets:
1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.

2.7 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING–SEE DRAWINGS

A. Utility Vault #444LA with 44-332P H20 cover for power. Utility Vault #264-T with H20 264TA cover for communications.

2.8 SLEEVES FOR RACEWAYS

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch (1.3- or 3.5-mm) thickness as indicated and of length to suit application.

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

2.9 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURE

A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
   1. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
   2. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:
   1. Exposed Conduit: Rigid steel conduit.
   2. Concealed Conduit, Aboveground: Rigid steel conduit, IMC, EMT.
   3. Underground Conduit: RNC, Type EPC-40-PVC, direct buried with plastic coated RGS or fiberglass bends and sweeps.
   4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
   5. Boxes and Enclosures, Aboveground: NEMA 250, Type 4.

B. Comply with the following indoor applications, unless otherwise indicated:
   1. Exposed, Not Subject to Physical Damage: EMT.
   2. Exposed and Subject to Severe Physical Damage: Rigid steel conduit. Includes raceways in the following locations:
      a. Loading dock.
   3. Concealed in Ceilings and Interior Walls and Partitions: EMT, MC Cable, or Flexible Metallic Conduit. Exception all circuit homeruns to panels shall be EMT.

4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
5. Damp or Wet Locations: Rigid steel conduit.
6. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless steel in damp or wet locations.

C. Minimum Raceway Size: Homeruns minimum 1-inch trade size. Other raceways may be ½-inch.

D. Communications (Telephone and Data): Shall be EMT in walls & overhead. Underground is not permitted except for connections between MDF and IDF's.

E. Raceway Fittings: Compatible with raceways and suitable for use and location.
1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with that material. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer.

F. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.

G. Do not install aluminum conduits in contact with concrete.

3.2 INSTALLATION

A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.

B. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

C. Complete raceway installation before starting conductor installation.

D. Support raceways as specified in Division 26 Section "Hangers, Supports and Fasteners."

E. Arrange stub-ups so curved portions of bends are not visible above the finished slab. Transition to RGS conduit for stub up.

F. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.

G. Conceal EMT within finished walls, ceilings, and floors, unless otherwise indicated.

H. Conceal conduit in rigid insulation space above ceiling deck in all exposed ceiling areas.

I. Raceways Embedded in Slabs:
1. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.

2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
3. Change from RNC Type EPC-40-PVC to plastic coated rigid steel conduit or EMT before rising above the floor.

J. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

K. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.

L. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire.

M. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where otherwise required by NFPA 70.

N. Expansion-Joint Fittings for RNC: Install in each run that is located where environmental temperature change may exceed 30 deg F (17 deg C), and that has straight-run length that exceeds 25 feet (7.6 m).
1. Install expansion-joint fittings for each of the following locations, and provide type and quantity of fittings that accommodate temperature change listed for location:
   a. Indoor Spaces: Connected with the Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.
   b. Attics: 135 deg F (75 deg C) temperature change.
2. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C) of temperature change.
3. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at the time of installation.

O. Flexible Conduit Connections: Use maximum of 72 inches (1830 mm) of flexible conduit for recessed and semirecessed lighting fixtures, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Use LFMC in damp or wet locations not subject to severe physical damage.

P. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.

Q. Set metal floor boxes level and flush with finished floor surface.

R. Stagger back to back outlets to acoustic wall. Similarly stagger back to back outlets where sound transmission is an issue in non-rated construction

3.3 INSTALLATION OF UNDERGROUND CONDUIT AND BOXES – SEE SECTION 26 05 43

3.4 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Rectangular Sleeve Minimum Metal Thickness:
   1. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side greater than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
   2. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches (1270 mm) and 1 or more sides equal to, or greater than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

E. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

F. Cut sleeves to length for mounting flush with both surfaces of walls.

G. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level

H. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway unless sleeve seal is to be installed or unless seismic criteria require different clearance.

I. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.

J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway, using joint sealant appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

K. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway penetrations. Install sleeves and seal with firestop materials. Comply with Division 07 Section "Penetration Firestopping."

L. Roof-Penetration Sleeves: Seal penetration of individual raceways with flexible, boot-type flashing units applied in coordination with roofing work.

M. Aboveground, Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

N. Underground, Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway and sleeve for installing mechanical sleeve seals

3.5 SLEEVE-SEAL INSTALLATION

A. Install to seal underground, exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway material and size. Position raceway in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.6 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

3.7 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
   1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
   2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 260533

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes requirements for raceways, fittings, and boxes specific to Division 27 and 28 which are additional to, or different from, that of Division 260533.

1.2 REFERENCES

A. The applicable portions of the following specifications, standards, codes and regulations (latest editions and/or amendments) shall be incorporated by reference into these specifications.
   1. General:
      a. National Electrical Code (NEC)
      b. National Electrical Safety Code (NESC)
      c. Washington Industrial Safety and Health Act (WISHA)
      d. Occupational Safety and Health Act (OSHA)
   2. Communications:
      a. TIA/EIA - 568A: Commercial Building Telecommunications Cabling Standard
      b. TIA/EIA - 568A2: Corrections and Additions to TIA/EIA 568A
      c. TIA/EIA - 569A: Commercial Building Standard for Telecommunication Pathways and Spaces
      d. TIA/EIA - 606: The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
      e. TIA/EIA - 607: Commercial Building Grounding and Bonding Requirements for Telecommunications
      f. TIA/EIA -TSB67: Transmission Performance Specifications for Field Testing of Unshielded Twisted Pair Cabling Systems
      g. ISO/IEC IS 11801: Generic Cabling for Customer Premises
      h. BICSI: BICSI Cabling Installation Manual

PART 2 - PRODUCTS

2.1 GENERAL

A. Materials shall consist of conduit, multi-outlet assemblies (SMR), device boxes, fittings, enclosures, pull boxes, hangers/supports, backboards, and other raceway incidentals and accessories as required and as detailed in Division 26 except where specifically noted below.

2.2 MATERIALS

A. Conduit: Minimum conduit size shall be 1 inch for communications, ¾” for electronic safety and security. Provide EMT, IMC or RGS
   1. Underslab: NOT ALLOWED for Telephone and Data Circuits. Only allowed for intercom/clock where specifically permitted by the installing manufacturer. Underslab for

other systems shall be PVC with long sweep Plastic coated rigid galvanized steel elbows and bends and must be acceptable to manufacturer.

B. Device boxes: Provide device boxes as follows:
   1. Device boxes shall be 4-11/16" x 4-11/16" x 2-1/8" deep depth with single or double gang extension rings (i.e. device covers, mud rings) unless otherwise noted on the Drawings. Combined depth of device box and extension ring shall be 2-3/4". Hubbell HBL260 and HBL263

C. Backboards: Provide backboards which are ¾" A-C fire treated plywood, void free, 8-ft high unless otherwise noted, capable of supporting attached equipment, and painted with a minimum of two coats of fire retardant light gray semi gloss paint.

D. Pull Boxes: Provide pull boxes (junction boxes) as shown on the Drawings and as required. 90 degree condulets (LB's) are not acceptable.
   1. Pull boxes shall be sized as follows:

Trade Size	Maximum For Each Box Size		Additional Conduit
Conduit	Width	Length	Depth Increase Width
1"	4"	16"	3" 2"
1-¼"	6"	20"	3" 3"
1-½"	8"	27"	4" 4"
2"	8"	36"	4" 5"

E. Firestopping: Provide firestopping material to maintain the fire rating of all penetrated walls, floors, and ceiling structures. Material shall be acceptable to the local fire and building authorities as well as applicable codes and shall be removable. Firestopping material shall be:
   1. Specified Tech. Inc.

F. Grounding Conductor: Provide #6 AWG insulated solid copper conductor (green) to bond all metallic raceway to the nearest grounding bus

G. Labels: Provide labels as recommended in TIA/EIA 606. Labels shall be permanent/legible typed and created by a Brady LS-2000 label maker or equivalent system. Handwritten labels are not acceptable. Labels are required for all raceway and pull boxes.

PART 3 - EXECUTION

3.1 GENERAL

A. All work shall comply with Division 260533.

B. The Contractor is solely responsible for the safety of the public and workers in accordance with all applicable rules, regulations, building codes and ordinances.

C. The Contractor shall follow all applicable safety rules and regulations including OSHA and WISHA. The National Electrical Safety Code (NESC) and the NEC shall be strictly followed except where local codes and/or regulations are more stringent, in which case the local codes and/or regulations shall govern.

D. All work shall comply with the standards, references and codes listed in Part 1 — References above. Where questions arise regarding which standards, references, or codes apply, the more stringent shall prevail.

E. The Contractor shall install all components strictly to manufacturers recommendations.

F. Install the raceway system in a manner ensuring that communications circuits, when installed, are able to fully comply with the TIA/EIA, ISO/IEC and BICSI references listed in Part 1 — References, above.

G. If raceway (conduits, sleeves, etc.) is installed after walls are installed and/or after finish to walls has been applied, wall penetrations shall be sealed, patched and painted to match condition and finish of undisturbed wall.

H. Upon project completion, all surplus material and debris shall be cleared from the job site and legally disposed of.

3.2 INSTALLATION

A. Conduit:
1. Run conduit in the most direct route possible, parallel to building lines. Do not route conduit through areas in which flammable material may be stored, or over or adjacent to boilers, incinerators, hot water lines, or steam lines.
2. Conduit bends:
   a. A conduit bend shall not exceed 90 degrees.
      1) For conduit up to 2”, the bend must be at least 8 times the internal diameter of the conduit.
      2) For conduit greater than 2”, the bend must be at least 10 times the internal diameter of the conduit.
   b. The sum total of conduit bends for a section of conduit shall not exceed 180 degrees, except as noted below:
      1) One additional bend of up to 90 degrees is acceptable if the bend is located within 12 inches of the cable feed end.
   c. 90 degree condulets (LB’s) are not acceptable.
3. Ream conduits to eliminate sharp edges and terminate with metallic insulated grounded throat bushings. Cap each conduit with a mechanical-type seal for protection. Equip all conduits with a plastic or nylon pull string with a minimum test rating of 200 lb.
4. Terminate conduits that protrude through a floor 1” to 3” above the surface of the floor.
5. Label each conduit end in a clear manner by designating the location of the other conduit end (i.e. room name, communications closet name, junction box number, etc.). Indicate conduit length on the label.

B. Device Boxes: Set device boxes plumb, level, square and flush with wall. Do not exceed more than 1/16” tolerance for each condition.

C. Pull Boxes: Install pull boxes in an exposed location, readily accessible both at time of construction and after building occupation. Pull boxes shall not be installed in interstitial building space.
1. Do not exceed one pull box per total conduit run between device box and termination point in a communications closet.

2. If mounting pull box on ceiling structure above ceiling grid, do not mount higher than 4' above grid (mount on wall instead).
3. A pull box may not be substituted for a 90 degree bend.
4. Install pull boxes such that conduit enters and exits at opposite ends of the box as follows:

D. Grounding/Bonding: All grounding and bonding work shall comply with the Uniform Building Code, Uniform Fire Code, WAC, National Electrical Code, UL 467, and ANSI/TIA/EIA standards listed in Part 1 — References above, as well as local codes which may specify additional grounding and/or bonding requirements.
   1. Bond all metallic raceway at both ends to the nearest grounding bus bar (as provided under Division 16740. Ensure that bonding breaks through paint to bare metallic surface of all painted metallic raceway.

END OF SECTION 260534

PART 1 - GENERAL

1.1 SUMMARY

A. This Section provides additional requirements to Section 260533

B. Provide all materials and labor for the installation of a pathway system underground circuits. Work in this section includes excavation and trenching, duct (raceway) construction, cutting and patching, concrete, handhole construction, and landscaping.
   1. This Section includes requirements for the above work which specifically pertain to outside plant communications and which are more stringent, additional to, or different from that of the Division 2, Division 3, Division 26, Division 27 and Division 28 sections.

C. HANDHOLES
   1. Each handhole shall be furnished with pulling eyes and framing channels.
   2. All manhole sumps shall be hard piped to drains, NO dry wells allowed.
   3. Each cover and door shall be marked with raised or depressed lettering at least 1 high as follows:
      a. Up to 600V power: ELECTRIC
      b. Communication Systems: COMMUNICATION
      c. Site Lighting Circuits: LIGHTING

1.2 REFERENCES

A. The applicable portions of the following specifications, standards, codes and regulations (latest editions and/or amendments) shall be incorporated by reference into these specifications.
   1. General:
      a. National Electrical Code (NEC)
      b. National Electrical Safety Code (NESC)
      c. Washington Industrial Safety and Health Act (WISHA)
      d. Occupational Safety and Health Act (OSHA)
      e. WSDOT/APWA 1998 Standards Specifications for Road, Bridge and Municipal Construction (APWA Standard Specifications)
   2. Communications:
      a. TIA/EIA - 758: Customer-owned Outside Plant Telecommunications Cabling Standard
      b. TIA/EIA - 568A: Commercial Building Telecommunications Cabling Standard
      c. TIA/EIA - 569: Commercial Building Standard for Telecommunication Pathways and Spaces
      d. TIA/EIA - 606: The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
      e. TIA/EIA - 607: Commercial Building Grounding and Bonding Requirements for Telecommunications
      f. ISO/IEC IS 11801: Generic Cabling for Customer Premises
   3. Trenching and Backfill:
      a. ASTM D1557: Test Method for Laboratory Compaction Characteristics Using Modified Effort

1.3 DEFINITIONS

A. Aggregate: The mineral materials such as sand or stone used in making concrete

B. Backfill: Earth material used specifically for filling and grading excavations back to a finished state. Backfill is placed on top of the bedding surrounding encased ductbanks and direct-buried conduits.

C. Base: Earth material used specifically to level and grade an excavation's subgrade for the subsequent placement of encased ductbanks, direct-buried conduit, and handholes. Base material is placed on top of the subgrade and beneath the bedding surrounding encased ductbanks, conduits, or handholes.

D. Bedding: Earth material used specifically for filling excavations. Bedding is placed around encased ductbank, conduits, or handholes. Bedding is placed on top of the base and beneath the backfill.

E. Fill: The collective term for base, bedding, and backfill.

F. RNC: Rigid Non-Metallic Conduit (PVC)

G. RGS: Rigid Galvanized Steel Conduit.

H. PSC: PVC Coated Rigid Steel Conduit.

PART 2 - PRODUCTS

2.1 GENERAL

A. Materials shall consist of fill, topsoil, concrete formwork, concrete, raceway, handholes, and other incidentals and accessories as required.

2.2 BASE, BEDDING AND BACKFILL

A. Use of on-site soils for base, bedding, and backfill is not acceptable.

B. Base: Base material shall have size and shape characteristics that will allow it to compact readily and shall conform with the following gradation requirements.

1. For handholes (provide gravel):

Sieve Size	Percent Passing
1" Square	100
¼ " Square	25 - 80
U.S. No. 200	15.0 max
Sand Equivalent	30 min

2. For Trenches (provide sand):

Sieve Size	Percent Passing
U.S. No. 10	35 - 100
U.S. No. 20	20 - 80
U.S. No. 40	10 - 55
U.S. No. 100	0 - 10

U.S. No. 200 0 – 3

C. Bedding: Same as Base - For Trenches, above.

D. Backfill:
1. For handholes - Same as Base - For handholes, above.
2. For Trenches

Sieve Size	Percent Passing
½ " Square	100
¼ " Square	65 - 100
U.S. No. 10	40 - 100
U.S. No. 50	3 - 50
U.S. No. 100	0 - 4
U.S. No. 200	0 - 3

2.3 DUCTS AND DUCTBANKS

A. Ducts: Provide in locations as shown on the drawings. Refer to Part - 3, Execution for details on when to use each type. All conduit, fittings, and adhesives shall be provided by the same manufacturer.
1. Types:
   a. Rigid Non-Metallic Conduit (RNC):
      1) RNC shall be NEMA TC 2 schedule 40 or 80 (see Part - 3, Execution for details on when to use each type) rigid polyvinyl chloride (PVC) approved for direct burial without concrete encasement. RNC shall be UL listed.
      2) Fittings shall be NEMA TC3, matched to conduit and material.
      3) Bends shall be PSC, taped steel, or fiberglass
   b. Rigid Galvanized Steel Conduit (RGS):
      1) RSC shall be rigid steel conduit hot-dipped galvanized inside and out with threaded ends meeting ANSI C80.1.
      2) Couplings: Unsplit, NPT threaded with galvanizing equal to and compatible with conduit. Running thread or set screw threaded fittings (except for three piece and watertight split couplings) are not acceptable.
      3) Nipples: Factory made through eight inches with no running threads.
   c. PVC Coated Rigid Steel Conduit (PSC):
      1) PSC shall be NEMA RN 1 rigid steel conduit coated with rigid polyvinyl chloride (PVC) inside and out.
      2) Fittings shall be NEMA RN 1.
2. Fittings:
   a. Bends/Sweeps:
      1) Unless otherwise noted on the Drawings, bends/sweeps shall be factory manufactured.
      2) Unless otherwise shown on the Drawings, bends shall consist of a single arc of not less than a 15 foot radius. Where this is not possible, a bend radius shall not be less than 10 times the internal diameter of the conduit for communications circuits.
      3) Unless otherwise shown on the Drawings, the use of 90 degree elbows, LB's, condulets, or the use of a handhole in place of a bend/sweep is not acceptable for communications circuits.
   b. End Caps (Plugs): Provide pre-manufactured water-tight end caps for all ducts during construction. Tape is not an acceptable end cap or cover.

c. End Bells: Provide end bells for terminating conduit in handholes. Do not provide for conduit ends terminating in handholes which are equipped with TERM-A-DUCT.

3. Pull Cords: Provide nylon pull cord indicating length measurement for each duct. Pull cord strength shall be a minimum of 130 pounds.

B. Ductbanks:

1. Duct Spacers/Supports: Provide high-density plastic interlocking spacers/supports to maintain uniformity of multiple ducts within a ductbank. Spacers shall be:
   a. Underground Devices Inc.: WUNPEECE
2. Warning Tape: Provide metallic warning tape above each ductbank. Tape shall be 6” wide and orange in color.
3. Grounding/Bonding: Provide #2 bare ground along length of ductbank.

2.4 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING–SEE DRAWINGS

A. Utility Vault #444LA with 44-332P H20 cover for power. Utility Vault #264-T with H20 264TA cover for communications.

PART 3 - EXECUTION

3.1 GENERAL

A. The Contractor is solely responsible for the safety of the public and workers in accordance with all applicable rules, regulations, building codes and ordinances. Fenced barriers, steel plate covers, warning indicators, proper shoring, etc. are all the sole responsibility of the Contractor.

B. The Contractor shall follow all applicable safety rules and regulations including OSHA and WISHA. The National Electrical Safety Code (NESC) and the NEC shall be strictly followed except where local codes and/or regulations are more stringent, in which case the local codes and/or regulations shall govern.

C. All work shall comply with the standards, references and codes listed in Part 1 — References above. Where questions arise regarding which standards, references, or codes apply, the more stringent shall prevail.

D. The Contractor shall install all components strictly to manufacturers recommendations.

E. Upon project completion, all surplus material and debris shall be cleared from the job site and disposed of in a legal manner by the contractor.

3.2 EXCAVATING, TRENCHING AND FILL

A. Excavation:

1. Excavations shall not be performed where the outside temperature is less than 35 F or when there is standing water or snow on the subgrade.
2. Excavations requiring crossing of concrete or asphalt shall be performed only after the surface material has been saw cut and removed. Concrete shall be removed in complete sections from control joint to control joint regardless of the width of the excavation.

Concrete and asphalt shall be replaced to match existing depth, strength, color, and type of material. Coordinate with and obtain approval from AHJ.

3. Adjacent structures which may be compromised or damaged by excavation work shall be underpinned as evaluated and recommended by a registered structural engineer employed by the contractor prior to proceeding with the work.
4. The Contractor shall maintain adequate separation between the excavation and adjacent underground utilities. The excavation shall be located such that ductbank and handholes, when installed, shall have a minimum separation of twelve (12) inches between the ductbank and handhole and the nearest underground utility. For gas lines a minimum separation of eighteen (18) inches is required. For water/sewer a minimum separation of thirty-six (36) inches is required.
5. Excavations shall not be left unprotected at the end of the work shift. Excavations shall be covered with steel sheets and barricaded prior to leaving the job site, in accordance with all applicable rules, regulations, building codes, and ordinances.
6. The Contractor shall not allow water to accumulate in excavations. The Contractor shall install, operate and maintain all pump or dewatering equipment necessary to meet this requirement.
7. Depth of excavation
   a. For handholes: Depth shall allow for the overall assembled height of the vault plus the added height of risers, covers and bedding material consisting of a minimum six (6) to twelve (12) inches of base. Width of excavation for handholes shall provide for a minimum of six (6) inches clearance around each side of the hanhole.
   b. For trenches: Depth shall be sufficient to cover a minimum of twenty-four (24) inches over the conduit or ductbank formation. Width of excavation for trenches shall be a minimum of six (6) inches to each side of the ductbank formation. Depth of excavation for trenches shall allow for the proper alignment of ducts into handholes.
8. Soft spots in the subgrade shall be over-excavated, filled, and compacted under supervision of soils engineer.
9. Excavation for trenching shall run true and as straight as practicable. Trenches shall be clear of stones and soft spots.
   a. Coordinate slope with actual conditions in field.
10. Trench grade shall be sloped to fall 3 inches per 100 feet in general and ¼" per foot where possible. Slope shall fall toward lower handholes or from high points toward both hanholes.

B. Fill:
1. Prior to the placement of fill, all groundwater and surface water shall be drained and/or pumped from the recipient area.
2. Frozen fill shall not be placed.
3. Base:
   a. The subgrade bed to receive fill shall be scarified and moisture conditioned prior to placing materials.
   b. Base material shall be moisture conditioned to within three (3) percent of optimum moisture content and shall be placed in loose, horizontal layers.
   c. The subgrade bed shall be leveled using sand for trenches and gravel for handholes as necessary to form an even base.
4. Bedding:
   a. For Direct-buried Ductbank:
      1) Lifts/layers shall not exceed 1 to 2 inches before compaction until the top of the ductbank is reached and shall not exceed 4 inches thereafter. Bedding shall be placed simultaneously on both sides of ductbank for the full width of the trench. The materials shall be carefully worked above, to each side, and

below the ducts with a tool capable of preventing the formation of void spaces and without damaging the structure or waterproofing of the ducts.

5. Backfill:
   a. Backfill lifts/layers shall not exceed 6 inches before compaction.
6. Compaction: Compaction shall be performed using a vibratory plate or roller or other mechanical device. Compaction through jetting and/or ponding is not acceptable. Compact per APWA Standard Specification Paragraph 7-10.3 (11).
   a. Bedding: Material shall be compacted to a dense state equaling at least 95% of the maximum dry density per ASTM D1557.
   b. Backfill: Material shall be compacted to within two (2) feet of the finished surface with a minimum relative compaction of 90% of the maximum dry density per ASTM D1557. Material within two (2) feet of the finished surface shall be compacted with a minimum relative compaction of 95% of the maximum dry density per ASTM D1557.

C. Waste Disposal: The Contractor shall remove all excavation materials and other construction debris from the site in a timely manner. Materials shall be disposed of legally.

3.3 DUCTS AND DUCTBANKS

A. Ducts:
1. The type of duct to use shall be dictated by the application:
   a. Outdoor underground – direct buried: Provide PVC Schedule 40 or 80 or plastic coated rigid galvanized steel (PSC).
      1) Transition to PSC at stub up locations and at entrances to buildings or other locations where the raceway changes from direct buried to encased in concrete or exposed conditions.
2. Fittings:
   a. Duct ends shall be cut square and reamed to remove burrs and sharp ends. Duct shall extend the maximum distance into all fittings, couplings, and/or connectors. All fittings shall be tightened securely and sealed watertight (see below).
      1) Ensure that bends/sweep radii are detailed on the drawings.
   b. Bends/Sweeps:
      1) Bend and sweeps shall be Plastic coated rigid galvanized steel.
      2) Unless otherwise shown on the Drawings, bends shall consist of a single arc of net less than a 15 foot radius. Where this is not possible, a bend radius shall not be less than 10 times the internal diameter of the conduit for communications circuits.
      3) Unless otherwise shown on the Drawings, an individual bend shall not exceed 90-degrees.
      4) Unless otherwise shown on the Drawings, a duct section may have no more than the equivalent of two 90-degree bends (a total of 180 degrees) between pull points. The 180-degree maximum shall include kicks and offsets. Where it is not possible to construct a section of duct within the 180-degree bend maximum, intermediary handholes must be installed.
      5) Two 90-degree bends separated by less than 10’ is not permissible.
      6) Bends for ducts within a common ductbank shall be parallel, measured from the same center-point.
      7) Where factory manufactured bends cannot be obtained due to a unique bend radius, bends shall be formed only with factory recommended equipment and shall be manufactured in such a way as to ensure that the internal diameter of the duct is not changed.

c. End Caps (Plugs): End caps shall be placed on all duct ends throughout construction in order to prevent the intrusion of water or debris. End caps shall be installed on all duct that is not directly being worked on during the work day and on all ducts at night. End caps shall be left in place upon final completion of the work.
d. End Bells: For handholes which are not equipped with TERM-A-DUCT, install protective end bells on ducts flush with handhole wall.

3. Sealing: Duct connections shall be made waterproof and rustproof by application of a watertight, conductive thread compound (for RGS and PSC) or by solvent-type cement (for RNC). Duct terminations in handholes shall be sealed and grouted (to ensure that all voids in the joints are filled).
4. Test Mandrels: Each duct, once installed, shall be cleaned of debris with a wire brush or swab and shall be proven out with a minimum 16 inch long test mandrel which is ¼ inch smaller than the inside diameter of the duct. Test mandrel shall be pulled after backfilling but prior to the replacement of landscaping. The Contractor shall repair any duct that does not prove out at no cost to the Owner.
5. Duct Entrances: Duct entrances at opposite ends of a handhole shall be at the same level and in the same position with respect to the side walls. The Contractor shall ensure that each duct leaving a handhole in any position shall enter the next handhole in the same relative position.
   a. Ensure that maximum lengths are calculated.
6. Length: Unless otherwise shown on the Drawings, the maximum length of a duct run shall not exceed 600 feet between handholes or pulling points. Install additional handholes as required to maintain spacing.
7. Pull Cords: Install in each duct immediately after the duct has been mandreled. Leave a minimum of 10 feet looped and tied off at each end of the duct.
8. Protection: Insure that after installation all duct coatings and finishes are without damage. Repair as follows:
   a. PVC Coated Rigid Steel Conduit: Patch all nicks and scrapes in PVC coating after installing conduits.
   b. Rigid Galvanized Steel Conduit: Repair damage to galvanized finishes with zinc-rich paint as recommended by the manufacturer.
   c. Rigid Non-metallic Conduit: Repair damage with matching touchup coating recommended by the manufacturer.

B. Ductbanks:
1. Duct Spacers/Supports: Supports shall be spaced on eight (8) foot centers if encased in concrete and five (5) foot centers otherwise. Spacers shall be interlocked horizontally only. Spacers encased in concrete shall be staggered at least six (6) inches vertically.
2. Warning Tape: Install metallic warning tape six (6) inches below grade and eighteen (18) inches above the ductbank.
3. Grounding/Bonding: Install ground wire along length of ductbank.

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.5-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch (25 mm) above finished grade.

D. Install handholes and boxes with bottom below the frost line.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.

F. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

END OF SECTION 260543

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Identification for raceway and metal-clad cable.
   2. Identification for conductors and communication and control cable.
   3. Underground-line warning tape.
   4. Warning labels and signs.
   5. Instruction signs.
   6. Equipment identification labels.
   7. Miscellaneous identification products.

1.2 QUALITY ASSURANCE

A. Comply with ANSI A13.1 and ANSI C2.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.145.

1.3 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual, and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 RACEWAY AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Color for Printed Legend:
   1. Power Circuits: White letters on a blue field. – 120
   2. Power Circuits White letters on black for 277/480
   3. Emergency Power: White on dark orange/red.

4. Fire Alarm: White on red.
5. Legend: Indicate system or service and voltage, if applicable.

C. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

D. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches (50 mm) wide; compounded for outdoor use.

2.2 CONDUCTOR AND COMMUNICATION- AND CONTROL-CABLE IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.

B. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

C. Aluminum Wraparound Marker Labels: Cut from 0.014-inch- (0.35-mm-) thick aluminum sheet, with stamped, embossed, or scribed legend, and fitted with tabs and matching slots for permanently securing around wire or cable jacket or around groups of conductors.

D. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch (50 by 50 by 1.3 mm), with stamped legend, punched for use with self-locking nylon tie fastener.

E. Write-On Tags: Polyester tag, 0.015 inch (0.38 mm) thick, with corrosion-resistant grommet and polyester or nylon tie for attachment to conductor or cable.
1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

2.3 UNDERGROUND-LINE WARNING TAPE

A. Description: Permanent, bright-colored, continuous-printed, polyethylene tape.
1. Not less than 6 inches (150 mm) wide by 4 mils (0.102 mm) thick.
2. Compounded for permanent direct-burial service.
3. Embedded continuous metallic strip or core.
4. Printed legend shall indicate type of underground line.

2.4 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment, unless otherwise indicated.

C. Baked-Enamel Warning Signs: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application. 1/4-inch (6.4-mm) grommets in corners for mounting. Nominal size, 7 by 10 inches (180 by 250 mm).

D. Metal-Backed, Butyrate Warning Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch (1-mm) galvanized-steel backing; and with colors, legend, and size required for application. 1/4-inch (6.4-mm) grommets in corners for mounting. Nominal size, 10 by 14 inches (250 by 360 mm).

E. Warning label and sign shall include, but are not limited to, the following legends:
1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM) or 42 INCHES (1067 MM)."

2.5 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. in. (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes.
1. Engraved legend with black letters on white face.
2. Punched or drilled for mechanical fasteners.
3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.6 EQUIPMENT IDENTIFICATION LABELS

A. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm). Overlay shall provide a weatherproof and ultraviolet-resistant seal for label.

B. Color scheme shall be white letters on blue for 120/208, white letters on black for 277/480, and white letters on red for emergency.

2.7 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.
1. Minimum Width: 3/16 inch (5 mm).
2. Tensile Strength: 50 lb (22.6 kg), minimum.
3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
4. Color: Black, except where used for color-coding.

B. Junction Boxes: All junction boxes shall be painted per the following color code:
1. Fire Alarm – Red
2. Security – Purple
3. Normal Power, 480V – Brown
4. Normal Power, 208V – Black
5. Emergency Power, 480V –Orange as allowed by inspector. Each orange to be different shade.
6. Emergency Power, 208V –Orange as allowed by inspector.
7. Intercom/Clock - Gray
8. Telephone – Blue
9. Television – Beige
10. Data – Blue

11. Low Voltage – Green

C. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

D. Panels and Equipment
1. Power 120 Volt: White letters on a blue field. – 120
2. Power Circuits 277 volt White letters on a black field - 277
3. Emergency Power: Blue on dark orange/red.– 120
4. Emergency Power: Black on dark orange/red - 277
5. Fire Alarm: White on red.
6. Legend: Indicate system or service and voltage, if applicable.

E. Receptacle Labels

1. Clear Dymo tape, ¼" high

PART 3 - EXECUTION

3.1 APPLICATION

A. Raceways and Duct Banks More Than 600 V: 4-inch- (100-mm-) wide black stripes on 10-inch (250-mm) centers over orange background that extends full length of raceway or duct and is 12 inches (300 mm) wide. Stencil legend "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch- (75-mm-) high black letters on 20-inch (500-mm) centers. Stop stripes at legends. Apply to the following finished surfaces:
1. Floor surface directly above conduits running beneath and within 12 inches (300 mm) of a floor that is in contact with earth or is framed above unexcavated space.
2. Wall surfaces directly external to raceways concealed within wall.
3. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings.

B. Accessible Raceways and Metal-Clad Cables More Than 600 V: Identify with "DANGER-HIGH VOLTAGE" in black letters at least 2 inches (50 mm) high, with self-adhesive vinyl labels or snap-around labels. Repeat legend at 10-foot (3-m) maximum intervals.

C. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A: Identify with orange self-adhesive vinyl label or snap-around label or self-adhesive vinyl tape applied in bands.

D. Accessible Raceways and Cables of Auxiliary Systems: Identify the following systems with color-coded, self-adhesive vinyl tape applied in bands or snap-around, color-coding bands: Color per J-Box label above.

E. Power-Circuit Conductor Identification: For primary and secondary conductors No. 4 AWG and larger in vaults, pull and junction boxes, manholes, and handholes use color-coding conductor tape. Identify source and circuit number of each set of conductors. For single conductor cables, identify phase in addition to the above.

F. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in same junction or pull box, use aluminum wraparound marker labels. Identify each ungrounded conductor according to source and circuit number.

G. Conductors to Be Extended in the Future: Attach marker tape to conductors and list source and circuit number.

H. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, signal, sound, intercommunications, voice, and data connections.
   1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
   2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
   3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and Operation and Maintenance Manual.

I. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable. Install underground-line warning tape for both direct-buried cables and cables in raceway.

J. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply self-adhesive warning labels. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.
   1. Equipment with Multiple Power or Control Sources: Apply to door or cover of equipment including, but not limited to, the following:
      a. Power transfer switches.
      b. Controls with external control power connections.
   2. Equipment Requiring Workspace Clearance According to NFPA 70: Unless otherwise indicated, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.

K. Instruction Signs:
   1. Operating Instructions: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
   2. Emergency Operating Instructions: Install instruction signs with white legend on a red background with minimum 3/8-inch- (10-mm-) high letters for emergency instructions at equipment used for power transfer and load shedding.

L. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
   1. Labeling Instructions:
      a. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high label; where 2 lines of text are required, use labels 2 inches (50 mm) high.
      b. Outdoor Equipment: Engraved, laminated acrylic or melamine label. Stenciled legend 4 inches (100 mm) high.

c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.

2. Equipment to Be Labeled:
   a. Receptacles with panel and circuit number
   b. Panelboards, electrical cabinets, and enclosures.
   c. Access doors and panels for concealed electrical items.
   d. Electrical switchboards.
   e. Transformers.
   f. Emergency system boxes and enclosures.
   g. Motor-control.
   h. Disconnect switches.
   i. Enclosed circuit breakers.
   j. Motor starters.
   k. Push-button stations.
   l. Power transfer equipment.
   m. Contactors.
   n. Remote-controlled switches, dimmer modules, and control devices.
   o. Power-generating units.
   p. Voice and data cable terminal equipment.
   q. Master clock and program equipment.
   r. Intercommunication and call system master and staff stations.
   s. Television/audio components, racks, and controls.
   t. Fire-alarm control panel and annunciators.
   u. Security and intrusion-detection control stations, control panels, terminal cabinets, and racks.
   v. Monitoring and control equipment.
   w. Uninterruptible power supply equipment.
   x. Terminals, racks, and patch panels for voice and data communication and for signal and control functions.
   y. Junction boxes: System, voltage and circuit with black pen.
   z. Receptacles in shop shall have clear label indicating panel and circuit.

3.2 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Attach nonadhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.

F. System Identification Color Banding for Raceways and Cables: Each color band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.

G. Color-Coding for Phase and Voltage Level Identification, 600 V and Less: Use the colors listed below for ungrounded conductors.
   1. Color shall be factory applied.
   2. Colors for 208/120-V Circuits:
      a. Phase A: Black.
      b. Phase B: Red.
      c. Phase C: Blue.
      d. Neutral: White
   3. Colors for 480/277-V Circuits:
      a. Phase A: Brown.
      b. Phase B: Orange.
      c. Phase C: Yellow.
      d. Neutral: Gray
   4. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

H. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.

I. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches (150 to 200 mm) below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches (400 mm) overall.

J. Painted Identification: Prepare surface and apply paint according to Division 09 painting Sections.

END OF SECTION 260553

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. System coordination study for normal and emergency systems.
   2. Short circuit study for normal and emergency systems.
   3. Protective device calibration and setting.
   4. Arc fault study per NEC 70E. Provide an Arc Flash Hazard Study for the electrical distribution system shown on the one-line drawings. The intent of the Arc Flash Hazard Study is to determine hazards that exist at each major piece of electrical equipment shown on the one-line drawings. This includes switchgear, switchboards, panelboards, motor control centers, automatic transfer switches, VFD's, and transformers. The study will include creation of Arc Flash Hazard warning labels. These labels serve as a guide to assist technicians and others in the selection of proper personal protective equipment when working around exposed and energized conductors. Electrical contractor shall install the labels.

1.2 SCOPE

A. It is the intent of these tests to assure that protective devices are operational, correctly applied, within industry and manufacturer's tolerances, and installed in accordance with the specifications. This effort should minimize the damage caused by any electrical failure. The testing agency shall verify that the electrical system and electrical equipment configuration matches the contract documents, vendor shop drawings, and the electric system coordination study recommended settings.

B. Prepare a coordination study for the specific electrical overcurrent devices and feeder lengths, to be installed under this project, from the primary overcurrent protective device to the branch circuit breaker panels to assure proper equipment and personnel protection.

C. The study shall present an organized time-current analysis of each protective device in series from the individual device back to the source at Puget Sound Energy. The study shall reflect the operation of each device during normal and abnormal current conditions, and confirm that devices are coordinated.

D. The study shall coordinate the emergency system to meet NEC 700. The system shall selectively coordinate to comply with all requirements of 700. all equipment provided under Panels, Switchboards, Circuit Breakers, Fusing, Controllers, etc. shall be designed and provided by the contractor to comply with the selective coordination requirements of the code. Study shall be completed and accepted by the engineer prior to ordering any equipment.

E. Provide arc fault/flash study per NFPA 70E.

F. Study shall be stamped by the coordination study engineer with a Professional Engineer's stamp from the State of Washington

G. Report shall not be submitted until complete compliance with NEC 700 is complete

H. Coordination Study Engineer report and stamp states that the coordination engineer is stating that the system complies with NEC 700.

1.3 APPLICABLE CODES, STANDARDS AND REFERENCES

A. Inspection and tests shall be in accordance with the following codes and standards except as provided otherwise herein:
   1. American National Standards Institute ANSI C2: National Electrical Safety Code
   2. American Society for Testing and Materials – ASTM
   3. Association of Edison Illuminating Companies – AEIC
   4. Institute of Electrical and Electronic Engineers – IEEE
   5. Insulated Cable Engineers Association – ICEA
   6. International Electrical Testing Association NETA Maintenance Testing Specifications MTS- 1989
   7. National Electrical Manufacturer's Association – NEMA
   8. National Fire Protection Association – NFPA
      a. ANSI/NFPA 70: National Electrical Code
      b. ANSI/NFPA 70B: Electrical Equipment Maintenance
      c. NFPA 70E: Electrical Safety Requirements for Employee Workplaces
      d. ANSI/NFPA 78: Lightning Protection Code
      e. ANSI/NFPA 101: Life Safety Code
      f. NFPA 70E
   9. Occupational Safety and Health Administration – OSHA
   10. State and local codes and ordinances

1.4 SUBMITTALS

A. Submit the following in accordance with Division 01:
   1. Protective equipment shop drawings with the protective device study. The one-line diagram showing available fault currents and timing of devices shall be submitted both as hard copies and as two electronic copies of Autocad drawings on Compact Disc. Two electronic copies of both the Dapper and Captor software files shall be provided on Compact Disc. An index shall be provided which cross references the file names on these disks to the specific pieces of equipment or system.
   2. Certifications: Two weeks prior to final inspection, the Contractor shall deliver four copies of the following certifications to the Owner's representative:
      a. That the protective devices have been adjusted and set in accordance with the approved protective device study.
      b. That tests and settings have been witnessed by the Owner.
      c. Report of results.
   3. Short circuit study in conjunction with, and at the same time as, the submittal for Panelboards. The study shall show fault currents available at key points in the system down to a fault current of 7000A. The purpose of this submittal is to verify the fault current ratings of the panelboards.

1.5 QUALIFICATIONS

A. The coordination study shall be prepared by qualified engineers of the switchgear manufacturer or an approved consultant. Provide pertinent information required by the preparers to complete the study.

B. The short circuit study and coordination study shall be performed on the Dapper and Captor computer software packages. No substitutions.

C. Preapproved: Electrotest, Power Systems Engineering, Siemens Engineering Service Division, Cutler Hammer.

PART 2 - EXECUTION

2.1 REQUIREMENTS

A. The complete study shall include a system one line diagram, short circuit and ground fault analysis, and protective coordination plots.

B. One-Line Diagram:
1. Show, on the one line diagram, electrical equipment wiring to be protected by the overcurrent devices installed under this project. Clearly show, on the one line, the schematic wiring of the electrical distribution system.
2. Show reference nodes on the one line diagram referring to a formal report, to include the following specific information:
   a. X/R ratios, utility contribution, and short circuit values (asymmetric and symmetric) at the bus of the main switchboard, and all downstream equipment containing overcurrent devices.
   b. Breaker and fuse ratings.
   c. Transformer KVA and voltage ratings, percent impedance, X/R ratios, and wiring connections.
   d. Voltage at each bus.
   e. Identifications of each bus.
   f. Conduit material, feeder sizes, and length.
   g. Calculated short circuit current.

C. Short Circuit Study:
1. Determine the available 3 phase short circuit and ground fault currents at each bus. Incorporate the motor contribution in determining the momentary and interrupting ratings of the protective devices.
2. The study shall be calculated by means of the Dapper computer software package. Pertinent data and the rationale employed in developing the calculations shall be incorporated in the introductory remarks of the study.
3. Present the data determined by the short circuit study in a table or report format. Include:
   a. Device identification.
   b. Operating voltage.
   c. Protective device.
   d. Device rating.
   e. Calculated 3 phase short circuit current (asymmetrical and symmetrical), and ground fault current.

D. Coordination Curves:
   1. Prepare the coordinations curves to determine the required settings of protective devices to assure selective coordination. Graphically illustrate on log-log paper that adequate time separation exists between existing and supplied series devices. Plot the specific time-current characteristics of each protective device in such a manner that all upstream devices will be clearly depicted on one sheet.
   2. The following specific information shall also be shown on the coordination curves:
      a. Device identifications.
      b. Time and current ratio for curves.
      c. ANSI damage points for each transformer.
      d. Complete fuse curves.
      e. Cable damage curves.
      f. Transformer inrush points.
      g. Maximum short circuit cutoff point.
   3. Develop a table to summarize the settings selected for the protective devices. Include in the table the following:
      a. Device identification.
      b. Tap, time delay, and instantaneous pickup.
      c. Circuit breaker sensor rating, long-time, short-time, and instantaneous settings, and time bands.
      d. Fuse rating and type.
      e. Ground fault pickup and time delay.
   4. Provide electronic copies of the Captor Data files on two Compact Discs. Provide a cross reference between the data file names and the hard copy tables and reports.

2.2 ANALYSIS

A. Analyze the short circuit calculations, and highlight any equipment that is determined to be underrated as specified or not coordinated. Propose approaches to effectively protect the underrated equipment. Proposed major corrective modifications will be taken under advisement by the Owner and further instructions will be given.

B. After developing the coordination curves, highlight areas lacking coordination. Present a technical evaluation with a discussion of the logical compromises for best coordination.

2.3 ADJUSTMENTS, SETTINGS AND MODIFICATIONS

A. Accomplish necessary field settings, adjustments and minor modifications to conform with the study without additional cost to the Owner. (Examples of minor modifications are trip sizes within the same frame, the time curve characteristics of induction relays, ranges etc.)

2.4 FIELD INFORMATION

A. Gather field information needed for the protective device study.

END OF SECTION 260573

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. Commissioning process requirements for Electrical systems, assemblies, and equipment.

B. Related Sections:

1. Section 019100 "General Commissioning Requirements".
2. Division 22 “Plumbing”.
3. Division 23 “Heating, Ventilating, and Air Conditioning (HVAC)”.
4. Division 26 “Electrical”.

2.1 GENERAL DESCRIPTION

A. Commissioning Authority (CA)

1. The CA has been contracted directly with the owner for this project. The CA has overall responsibility for planning and coordinating the commissioning process. However commissioning involves all parties to the design and construction process, including the electrical (Division 26) contractor, as many HVAC system components require electrical power and controls in order to operate as specified.

B. Contractor Responsibility

1. The electrical (Division 26) contractor’s responsibilities are defined in Section 019100 of the specifications. Each contractor and supplier within Division 26 shall review Section 019100, and their bids shall include for carrying out the work described, as it applies to each Section within the Division 26 specifications, individually and collectively.

C. Electrical Equipment and Systems to be Commissioned

1. Interior lighting and controls systems
2. Metering

PART 2 - PRODUCTS

A. Refer to Section 019100 “General Commissioning Requirements” for minimum testing instrumentation criteria and performance.

B. Standard certified test equipment for commissioning will be provided by the Commissioning Authority.

C. All proprietary testing equipment and instrumentation required to verify and test system and equipment performance (including NETA testing) shall be provided by installing contractor and made available to the Commissioning Authority.

PART 3 - EXECUTION

1.1 GENERAL TESTING REQUIREMENTS

A. Contractor shall provide technicians, instrumentation, and tools to perform commissioning tests at the direction of the CA and as outlined in Section 01 91 00 "General Commissioning Requirements".

B. Scope of electrical testing shall include the entire electrical installation, from central equipment through distribution systems. Testing shall include measuring capacities and effectiveness of operational and control functions.

C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system (BAS) controllers and sensors.

D. The CA shall prepare detailed testing plans, procedures, and checklists for electrical systems, subsystems, and equipment.

1. NETA: The 3rd party electrical testing contractor shall utilize their standard testing documentation per NETA specifications and shall submit under separate cover.

E. Tests will be performed using design conditions whenever possible.

F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.

G. The CA may direct that set points be altered when simulating conditions is not practical.

2.1 INSTALLATION VERIFICATION AND START-UP ACTIVITIES

A. Refer to General Commissioning Specification Section 019100.

B. Provide overcurrent protective device coordination study and arc flash hazard analysis report.

3.1 POINT TO POINT VERIFICATION AND FUNCTIONAL PERFORMANCE TESTING

A. Refer to General Commissioning Specification Section 019100.

B. Functional performance testing and verification may be achieved by manual testing (persons manipulate the equipment and observe performance) or by monitoring the performance and

analyzing the results using the control system's trend log capabilities or by stand-alone dataloggers.

C. Simulated Conditions. Simulating conditions (not by an overwritten value) shall be allowed, though timing the testing to experience actual conditions is encouraged wherever practical.

D. Overwritten Values. Overwriting sensor values to simulate a condition, shall be allowed, but shall be used with caution and avoided when possible. Such testing methods often can only test a part of a system, as the interactions and responses of other systems will be erroneous or not applicable. Simulating a condition is preferable than overwriting the value or by altering the appropriate setpoint to see the desired response. Before simulating conditions or overwriting values, sensors, transducers and devices shall have been calibrated.

E. Altering Setpoints. Rather than overwriting sensor values, and when simulating conditions is difficult, altering setpoints to test a sequence is acceptable.

F. Setup. Each function and test shall be performed under conditions that simulate actual conditions as close as is practically possible. The Sub executing the test shall provide all necessary materials, system modifications, etc. to produce the necessary flows, pressures, temperatures, etc. necessary to execute the test according to the specified conditions. At completion of the test, the Sub shall return all affected building equipment and systems, due to these temporary modifications, to their pre-test condition.

4.1 TRAINING

A. Refer to General Commissioning Specification Section 019100.

5.1 OPERATION AND MAINTENANCE MANUALS

A. Refer to General Commissioning Specification Section 019100.

END OF SECTION 260800

PART 1 - GENERAL

1.1 OVERVIEW

A. Provide a complete low voltage lighting control system for the building as shown on the plans and specified herein.

B. Shall utilize networking technology connecting relay panels, switches and sensors based upon a 2 wire data line providing both power and data to all devices. The network shall be free topology; therefore a serial loop is not necessary to achieve maximum network distance. The system shall utilize a web server device complete with a touch screen located in a relay panel so that programming and viewing of status can be accomplished at the panel or by any PC connected to the same LAN or via the internet.

C. All relay panel interiors shall be pre-assembled complete with the necessary relays, transformers and devices. Relay panels that are wall mounted shall have interiors separate from enclosure so as to permit easy mounting, conduit installation and wire pull to enclosures. Enclosures mounted in the ceiling space are not required to have separate interiors.

1.2 MANUFACTURERS

A. All components are to be supplied by same manufacturer. Manufacturer to be a supplier of this type of equipment for over 10 years.

B. Digital Lighting control system shall be the Dialog system manufactured by Douglas Lighting Controls.

1.3 PRIOR APPROVAL SUBMISSIONS

A. Manufacturers wishing to submit quotations on the lighting control system must pre-qualify. Pre-qualification information must be submitted to the electrical consulting engineer not later than ten (10) working days prior to the final closing of tenders for this project.

B. The manufacturer must be prepared to demonstrate the equipment being proposed before the closing of tender.

C. Submit a one-line diagram of the proposed system configuration for review.

1.4 INSTRUCTION MANUALS

A. Supply manuals on system components to permit ease of installation, system operation and maintenance including, but not limited to the following:
   1. Lighting control system step-by-step operating instructions.
   2. Relay panel schedules indicating circuits connected, inputs assigned, area controlled, panel location and panel equipment details.

PART 2 - MATERIALS

2.1 DIGITAL LIGHTING CONTROL SYSTEM

A. Relays
1. Lighting control relays shall be mechanically latching and shall come complete with a manual ON/OFF switch. The mechanical switch shall continuously display the true state of the relay's internal contacts.
2. Single pole relays shall be rated and UL/CSA listed for 120, 277and 347 VAC lighting loads at 20 amps. Use Douglas WR-6161.
3. Double pole relays shall be rated and UL listed for 208, 240 or 480 VAC and CSA for up to 347 VAC lighting loads at 20 amps. Use Douglas WR-6172.
4. The relays shall have a label indicating the short circuit fault current rating as per the NEC 2014. The relays shall have passed UL 508 short circuit tests matching the adjacent panel and in most cases is 35,000 AIC
5. Each lighting control relay shall be capable of controlling incandescent, fluorescent, electronic ballast and H.I.D. lighting loads and have an inrush capability of 3000 amperes. Relays shall be complete with a 5 year Manufacturer's Limited Warranty.
6. Lighting control relays shall include captive screw terminals for both the line voltage and the low voltage connections. Switching the relay shall be accomplished with ONE signal wire and a common return. The signal wire shall be able to signal ON and OFF and shall carry status current that indicates if the relay is ON or OFF.

B. Pre-assembled Relay Panels: PWEx Series
1. Where indicated on the drawings, provide a factory pre-assembled relay panel. The panel's enclosure shall be for surface or flush installation, with a hinged door assembly as required.
2. The panel shall consist of a pre-assembled interior insert; UL/CSA approved Douglas Cat No: CxxM or WxxM series with capacities for 12, 24, 36, 48 or 72 relays as required. Panel enclosure must be UL/CSA Approved. Relay panels shall provide minimum additional 25% space for future growth.
3. Panel interior shall have the following pre-assembled and pre-wired:
   a. Suitable divider separating class 1 and class 2 compartments.
   b. Control transformer, UL/CSA approved for class 2 circuits, Douglas Cat. No. WR-4075-xxx where xxx = primary voltage.
   c. Low voltage relays as required by switched circuits shown on plans or schedules.
   d. Control devices as required.

C. Device Network Controls

1. The Douglas Lighting Controls Dialog WLC-4150 Lighting Control Unit (LCU) shall be able to operate the local lighting control system on a stand-alone basis. For large installations that require multiple LCUs, all units must be able to operate on a stand-alone basis should they become disconnected from the network.
2. The LCU shall provide the following user interfaces for viewing and editing data:

   a. Built-in touch screen with editable IP address field for convenient at panel configuration and providing web accessible configuration.
   b. Built-in web server, accessed via TCP/IP connection.
   c. LCU shall be accessible via a web browser with no additional software required.

3. Each LCU shall provide the following standard lighting control functions:

a. Program and control up to 252 relays and 252 dimmers.
b. Link Outputs to switches and/or sensors to provide ON/OFF, Preset, or Dim Up/Down commands. In addition, functions such as Flick Warn, Time Out, Natural Daylight, Enable/Disable and Quiet Time can be associated with switches, sensors and relays and have these features scheduled by time-of-day or date.
c. Be able to group Outputs and Inputs to facilitate various control schemes.
d. Be able to program peripheral devices (switches, sensors, etc.) to function differently based on specific situations such as time-of-day, demand response status, user intervention, etc.
e. Photo Sensor to provide Dusk-to-Dawn (switching) and/or Natural Daylight (dimming) with multiple set points to different groups.
f. Astronomic Controls for Dusk-to-Dawn applications not requiring Photo Sensor.
g. Provide Log Reports for diagnostic and run-time tracking purposes.
h. Time Schedule types include: 7-day weekly scheduling, 365-day date specific, Holiday, and event scheduling.

4. The system shall have pre-defined logical applications for lighting controls.

a. Astronomical Time Clock
b. Natural Daylight (CLC) – Open Loop & Close Loop
c. Exterior Threshold Photo Control
d. Time Out (Unoccupied Mode)
e. Quiet Mode
f. Permanent Block
g. Flick Warn

5. The system must shall the ability to operate multiple items and modes with a single action and sequence them with time offsets.
6. Behaviors: The system shall have the ability to program multiple actuations and modes with a single activation. Each item must be able to be programmed with a time offset. When the deactivation occurs a separate and unique list of actuations can be programmed.
7. Triggers: The system shall be able to utilize the status or the one or many relay/group statuses to send an actuation to the system. The statuses must be able to be programmed in an AND or OR logic.
8. Each LCU shall provide the following system functions:

a. Demand response: connection via contact input.
b. Accept configuration updates via USB port or Ethernet connection.
c. Backup data via Ethernet or USB port.

2.2 DIALOG ROOM CONTROLLER: WRC-3160

A. Where indicated on the drawings provide a pre-configured, digitally addressable, plenum-rated room controller.

B. The Dialog Room Controller shall be capable of:

C. Autonomously controlling a space.

D. Networking to a central Dialog control system.

E. Networking to a central BACnet based management system.

F. The Dialog Room Controller shall consist of:

1. Auxiliary contact for connection to the DDC system
2. A universal voltage type (120Vac/277Vac/347Vac) power supply.
3. Four 20A rated relays complete with manual override. Circuit Load rating dependent on usage. One circuit dedicated for 20A receptacle control.
4. Four 0-10V control channels, capable of 100mA current sinking
5. A port to connect downstream switches, occupancy sensors and daylight sensors. All downstream devices shall connected via two #18AWG, non-polarized, non-shielded, non-twisted conductors. See Section 3.4 for wiring specifications.
6. A port to connect to an upstream Dialog Lighting Control Unit.
7. A port to connect upstream to BACnet IP building management system. The Controller shall communicate using native BACnet command objects appropriate for the application.
8. An indicating LED to aid in locating the controller in a darkened ceiling space.
9. Circuit testing buttons
10. Capable of connecting with WUL-3924
11. Output 24Vac 120mA
12. Relay Ratings

    a. 20A Suitable for General Purpose Loads @ 120/277/247VAC
    b. 20A Suitable for Standard Ballasts and Tungsten Loads @ 120/277VAC
    c. 15A Suitable for Standard Ballasts Only @ 347VAC
    d. 16A Suitable for Electronic Ballasts @ 120/277VAC
    e. 0.5HP @120/277Vac
    f. US & Canada Plenum Rated

13. The Dialog Room Controller relays shall be connected such that 120Vac plug load(s) and 277Vac/347Vac lighting loads can be switched by a single Controller with no additional add-ons or remote modules
14. The Dialog Room Controller shall mount to electrical junction box via threaded ½" chase nipple. No other mounting hardware shall be required.

2.3 DIALOG ROOM CONTROLLER UL924 RELAY EXPANSION PACK: WUL-3924

A. At all emergency fixtures provide a 2-relay expansion pack consisting of two independently controllable, 20A relays capable of emergency lighting circuit control.

B. Expansion pack relays shall force EM lights on when the Dialog Room Controller loses power.

C. The expansion pack shall connect to the Dialog Room Controller. No wires or tools shall be required to add an expansion pack to a Dialog Room Controller. The Dialog Room Controller will include a means for remote mounting if required.

D. Circuit testing buttons

E. Capable of connecting directly to WRC-3160

2.4 RELAY CONTROLS INSTALLED IN RELAY PANELS - RELAY DRIVERS: WRD-3408

A. The low voltage relays shall be connected to the Dialog system by a Douglas Lighting Controls WRD-3408 relay driver unit. Each WRD-3408 relay driver has 8 outputs and shall provide enough relay driver units so that each relay in the system is connected to an output.

B. Relay drivers shall be able to control relays ON and OFF, determine relay status, provide feedback as to whether a relay is connected and be addressable within the Dialog network.

2.5 DIMMING CONTROL: WDB-3314

A. The Dialog system shall be able to control industry standard or 0-10VDC LED drivers by using the Douglas Lighting Controls WDB-3314 Dimming Ballast Module. Each WDB-3314 shall have 4 dimming address outputs, be able to support 35 devices per output and support sink current of 100mA per output.

B. Switching control: Provdie switching and plug load control as shown on the drawings. All plug loads shall operate on a timer schedule.

2.6 BACNET IP GATEWAY: WNG-3131

A. The system shall have the ability to communicate to a system integrator (DDC) to program the system through a Douglas Lighting Controls WNG-3131. It shall be possible to view/control the system via the BACnet integration software through TCP/IP connection. The system shall provide the following features:

1. Program and control up to 252 relays and dimming points.
2. Control and receive status for Groups
3. Control and receive status for Presets
4. Receive status from Occupancy Sensors

B. IP

1. In addition provide connection to the system to allow remote login to a web server based software system.

2.7 GLOBAL WEB SERVER: GWS-XXXX

A. The Douglas Lighting Controls GWS-xxxx shall be able to operate the entire lighting control system from a single interface.

B. The GWS shall provide the built-in web server interfaces for viewing and editing data, accessed via TCP/IP connection and connect to a PC/laptop using IE9+.

C. The GWS will give access to up to 25 LCUs and shall provide the following standard lighting control functions within each LCU:

1. Program and control up to 252 relays and 252 dimmers.
2. Link Outputs to switches and/or sensors to provide ON/OFF, Preset, or Dim Up/Down commands. In addition, functions such as Flick Warn, Time Out, Natural Daylight,

Enable/Disable and Quiet Time can be associated with switches, sensors and relays and have these features scheduled by time-of-day or date.

3. Be able to group Outputs and Inputs to facilitate various control schemes.
4. Be able to program peripheral devices (switches, sensors, etc.) to function differently based on specific situations such as time-of-day, demand response status, user intervention, etc.
5. Photo Sensor to provide Dusk-to-Dawn (switching) and/or Natural Daylight (dimming) with multiple set points to different groups.
6. Astronomic Controls for Dusk-to-Dawn applications not requiring Photo Sensor.
7. Provide log reports for diagnostic and run-time tracking purposes.
8. Time schedule types include: 7-day weekly scheduling, 365-day date specific and event scheduling.

D. The GWS-xxxx shall provide the additional following system functions:

1. Centralized Programming
2. Synchronization of time clocks
3. Download and upload of all system files
4. OPC Server Deployment
5. The ability to operate with an GUI interactive floor plan

2.8 WALL SWITCHES & ACCESSORIES

1. Switches shall be Douglas Lighting Controls WSW-35xx and connect to the lighting control network via a common 2-wire, non-polarized data line. Switches shall be configured and programmed to control one or more outputs in the lighting control system.
2. Switches shall have the capability to be configured an Douglas Lighting Controls WIR-3110 infrared setting unit that accesses programming fields of the switch without removing the switch from the wall box.
3. Switches are linked to a single output or a group of outputs.
4. Switches, Occupancy Sensors and Photo Sensors can be set to a common output address to permit multiple points of control for a single relay or dimming output.
5. Switches, Occupancy Sensors and Photo Sensors can be set to a common group address to permit multiple points of control for a group of outputs.
6. Each switch can be programmed for ON/OFF control of outputs, UP/DOWN control of 0-10VDC dimming ballasts, 0-10VDC LED drivers and/or preset control to set a specific lighting scene.
7. Switches, with LED indicators to indicate both ON and OFF output/group status, shall be available with 1, 2, 3, 4 or 8 single button switches per gang. Switch to fit standard Decora opening.
8. Switches and switch hardware shall mount to standard wall boxes.
9. Each switch shall provide a location for a label to identify function. The label shall be under a clear plastic cover and shall be field replaceable should the operation of the switch change. Permanently etched switches are not acceptable.
10. Adhere to the factory recommended wiring practices so that physical removal of any single switch shall still permit communication between relay panels in the rest of the Dialog lighting control network.

2.9 KEYED SWITCHES: WSK-35XX SERIES

1. Keyed switches shall be Douglas Lighting Controls WSK-3502 and connected to the lighting control network via a 2-wire, non-polarized data line.

2. Keyed ON/OFF switches shall include LED indicators for ON and OFF status.
3. Keyed switches can be programmed to control individual outputs or groups of output and can also be programmed to enable/disable peripheral devices such as switches or sensors.
4. Each keyed action, clockwise and counter-clockwise, shall allow for independently programmed functions.
5. Keyed switches can be programmed with a Douglas Lighting Controls WIR-3110 infrared setting unit.

B. Dimmer Switches: WSD-35xx series

1. Dimmer switches shall be Douglas Lighting Controls WSD-3501 and connected to the lighting control network via a 2-wire, non-polarized data line. Each switch shall be capable of raising or lowering light levels of individual or groups of lighting fixtures.
2. Switches shall include integral LED indication for light levels as well as a switch for ON/OFF control.
3. Dimmer switch can be programmed with a Douglas Lighting Controls WIR-3110 infrared setting unit.
4.

C. Occupancy Sensor

1. Sensors shall be Dialog WOR series Dual Technology with Passive Infrared (PIR) and ADI-Voice detection.
2. Ceiling sensors shall mount recessed in to the ceiling space.
3. Sensors shall have a 360 degree coverage pattern with an adjustable tilt head to maximize coverage, focus on particular areas, or provide adjustment when mounted on sloped ceilings.
4. Sensors shall provide an adjustable time out period of 30 seconds to 30 minutes.
5. A Douglas Lighting Controls WR-4075 transformer shall be used if required.
6. If a Photo Sensor is required, it shall be incorporated into the Occupancy Sensor device and operate so that when occupancy is detected, the sensor will only allow the load to be switched ON if the light level is below the daylight level set by the user.
7. A Manual Override Switch is to be provided on the sensor to allow the load to be manually switched ON and OFF for the purpose of testing during installation.
8. Where 2 level switching is required, a 2-pole sensor shall be provided. The sensors must be able to be set to activate alternating poles to provide even lamp wear.
9. Provide as required on the plans, options that are available from the following list:

    a. 0-10VDC outputs for dimming ballast option for Natural Daylight with user settable light levels
    b. Configurable high and low light level set points so that the sensor can toggle between light levels upon occupancy
    c. Auxiliary relay, for signaling other systems, which can be configured so that it synchronizes with the ON/OFF status of the load or the status of occupancy/vacancy
    d. Remote Manual Override Switch, Douglas Lighting Controls WR-86xx series switch

D. WCI-3928 Contact Input for occupancy sensors
1. When occupancy sensors by other manufacturers are required, provide WCI-3928 -8 Contact Input units. Each unit shall provide or DC to power each sensor and will accept a contact closure from each sensor which can be assigned to any relay or group. Check with factory to ensure compatibility.

2. Sensors connected to input unit to include the following features adjustable via system:
   a. Adjustable time out (3 min to 30 min)
   b. Function select - on/off switching, off-only switching.
   c. Multiple sensors may work together using either direct connection to sensors or via multi-sensor function built into WCI-3928 units.

E. Photo Sensor & Daylight Controls

1. Provide where required a Douglas Lighting Controls WPS-3711 Interior Daylight Sensor capable of sensing from 0 to 65,000 lux (0 to 6500 fc) of direct light. The sensor shall derive both its power and data information from the Dialog data line.
2. The ambient light level shall be continuously monitored in lux by the sensor. The sensor shall broadcast to the network the existing light level when requested or when there is a change in detected light level.
3. Set point adjustments can be made via a touch screen or web server interface to the Douglas Lighting Controls WLC-4150 LCU or on the WLC-4150.
4. Each sensor can be programmed to provide ON/OFF control of relays, raise/lower of 0-10vdc type or ballasts and LED drivers via a touch screen or web server interface to the Douglas Lighting Controls WLC-4150 LCU or on the WLC-4150.
5. One sensor shall permit different outputs to switch and/or control light levels as ambient light changes. Light levels shall be controlled by ‘sensor only’ or in combination with a time schedule or with a dimming switch.
6. It shall be possible to set a maximum light level which cannot be exceeded during Natural Daylight operations or for non-daylight controlled areas, a permanent or “tuned” light level to maximize energy savings.

2.10 HANDHELD PROGRAMMER

A. Handheld Programmer: WIR-3110

B. Provide a WIR-3110 Handheld Programmer to facilitate the following functions:

1. Set switch type and address
2. Create presets
3. Calibrate photo sensors and set addresses and light levels
4. Set addresses of motion sensors

2.11 SPARE PARTS

A. Dimming Controllers – 2

B. Photocells – 2

C. Occupancy Sensors – 5

D. Wall Switches – 3

E. Occupancy Sensor Wall Switches – 4

F. Relays – Per schedules on drawings

PART 3 - INSTALLATION

3.1 FACTORY STARTUP

A. The manufacturer’s authorized representative shall visit the site minimum 3x during construction to train the contractor on installation.

B. System shall be programmed per the lighting control schedule

C. Label all controllers

D. Establish IP connection to allow for remote programming

1. Send all IP requirements to the owner minimum 1 month before substantial completeion

E. Prior to punchlist by design team, manufacturer’s representative shall visit site and test all rooms for operation. Provide complete checklist to design team showing function of all spaces.

3.2 RELAY PANELS AND CONDUIT.

A. Ensure that conduit for line voltage wires enters panel in line voltage areas and conduit for low voltage control wires enters panel on low voltage areas. Check manufacturer’s drawings for location of line and low voltage areas.

3.3 DAYLIGHT SENSORS

A. Locate daylight sensors as per manufacturer’s recommendations for closed loop and open loop applications. Ensure there is no artificial light shining directly into the sensor head.

B. Adhere to manufacturer’s recommendations for wiring and programming.

3.4 OCCUPANCY SENSORS

A. Locate sensors so there are no objects blocking the infra red sensor from viewing all of the coverage area. Keep away from HVAC vents and direct light from light fixtures.

B. Adhere to manufacturer’s recommendations for location, wiring and programming.

3.5 WIRING

A. For low voltage wiring, provide wire type as recommended by the manufacturer.

B. Adhere to manufacturer's recommendations as to maximum wire length and maximum quantity of relays per switch.

C. Dialog Data line shall be single pair#18 LVT wire type, plenum rated or equivalent.

3.6 LINE VOLTAGE WIRING

A. Use wire gauges from #12AWG to #14AWG as appropriately sized for the branch circuit.

3.7 TRAINING

A. Provide minimum 2 x 4 hour training sessions for the owner’s personnel

END OF SECTION 260923

PART 1 - GENERAL

1.1 SUMMARY

A. Work Results: Furnish and install a complete package of Dimming and Control equipment for the House, Work and Theatrical Lighting in the Auditorium / Stage

B. Related Requirements: Drawings and general provisions of the Contract, including General and Special Conditions and other Division-01 General Requirement sections, apply to the work in this section.

1.2 PRICES AND PAYMENT PROCEDURES

A. Allowances: There are no allowance items in this section.

B. Unit Prices: There are no unit price requirements in this section.

1.3 SUBSTITUTIONS:

A. As required under Division 1, except where additional requirements are listed in this and other individual Sections referenced herein.

B. All bids shall be submitted based exactly on the contents and brand/models as specified of the TL series drawings. No product or device may be substituted without written authorization from the Theater/Assembly Space Consultant. TELEPHONE REQUESTS FOR APPROVAL WILL NOT BE ALLOWED. Only properly completed and signed CSI Substitution Request Forms with full technical catalog data sheets will be considered.

C. Pre-bid approval of substitute product manufacturers does not relieve the contractor and/or the product manufacturer from compliance with the functional and operational requirements of the Specifications. All products will be carefully evaluated during the submittal review process. If, at that time, any pre-bid approved substitute is found to be unsatisfactory and not in compliance, the contractor then must re-submit and supply the specified product(s) without additional costs to the Owner and/or delay to project.

D. If a manufacturer is listed in this section of the Specification as an approved equivalent, but no specific product model is listed, then the Contractor must submit complete factory technical data sheets and a Bill of Materials of the factory’s interpretation of equivalent product, along with their CSI Substitution Request. Such submittal shall be handled in review as a pre-bid substitution request.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Mixing of Manufacturers: All products described in this Section of the Specifications shall originate from a common manufacturer, or shall be components from multiple manufacturers which are integrated through factory engineering by a single manufacturer.

B. Provision, installation, and connection of line and load side electrical conduit and wiring for Dimming equipment shall be performed under Division 26.

C. Provision, installation and connection of all Control wiring and conduit shall be performed under Division 26.

D. Provision and installation of all raceways, disconnect and overcurrent means shall be performed under Division 26.

E. Receiving, uncrating and installation of all dimming and control equipment shall be performed under Division 26.

F. Some Stage Lighting Distribution Devices under Section 26 09 62 may contain control devices specified in this section. Refer to Schedules and Diagrams on TL Drawings for identification of specific devices.

G. Project Meetings: Refer to Division 01 requirements.

H. Preconstruction Evaluation: Refer to Division 01 requirements.

I. Construction Documentation: Refer to Division 01 requirements.

J. Special Administrative Requirements: Refer to Division 01 requirements.

1.5 SUBMITTAL REQUIREMENTS

A. Submittals for Review: Provide Manufacturer’s Data / Specification Sheets and Bill of Materials cross-referenced to TL drawing Control ID tags.

B. The submittals shall include catalog data sheets with the particular product item called out by red arrow. Submittals shall include factory dimensional and installation drawings. Submittals shall show all components of the entire system, even if components are defined as future or deferred or supplied by a different manufacturer but their presence as part of the total lighting control system affects or is affected by the equipment of the primary manufacturer specified herein. Submittals shall indicate which status is applicable for such items.

C. Submittals shall use the unique equipment ID numbers in pentagon and diamond tags, identical to the drawings and schedules.

D. Shop Drawings: Indicate all major system components by manufacturer's catalog number. Provide catalog cuts and operational and technical specifications for all major system components. Provide detailed fabrication drawings for all custom fabricated equipment.

E. Samples: Refer to Control Device Schedule on TL series drawings for any specific sample requirements.

F. Submittal documentation shall indicate by a “dashed” condition and tabular listing all deferred devices or equipment. Submittals shall show all components of the entire system, even if components are defined as deferred, furnished by others or future.

G. The Contractor shall bear the responsibility to ensure that the submittals are integrated regardless of the distribution of product among manufacturers. This is particularly true in terms of the lighting control system interconnect diagram.

H. The consultant shall review the submittals one time. If submittal review due to manufacturer’s errors or improper submission becomes excessive, the Contractor shall reimburse the Consultant for all excess hours at the Consultant’s principal hourly rate.

I. Manufacturer of dimming and controls shall incorporate submittal documents for distribution devices of Section 26 09 62.

J. The Contractor, and the manufacturers whose products are selected by the Contractor, shall provide a fully functional system documented in detail in the submittals. If the Architect or Theater Consultant does not discover missing or conflicting elements in the submittals that are in conflict with the contract documents, the Contractor and the manufacturers are still required to comply with the contract documents.

K. System drawings portion of submittals shall be formatted to be completely legible without visual aids or enlargement, at an 11 x 17 plot size sheet, and shall be submitted at no smaller size for review.

L. Provide above items in electronic form. Low resolution scan of a 1st generation physical plot is not acceptable.

1.6 REFERENCES

A. Abbreviations and Acronyms: Refer to TL0.10 for any special definitions related to this work

B. Definitions: Refer to TL0.10 for any special definitions related to this work

C. Reference Standards:

1. The following listed codes, standards, and regulations refer to the latest current edition and are to be considered a part of this Section: ASTM, AISC, NEC, NESC, NEMA, NFPA, UL, IEEE, ANSI, USITT, PLASA, ESTA, OSHA, and IBC.
2. All equipment where applicable standards have been established shall be listed and labeled by Underwriter's Laboratories or other locally approved testing agency. All Lighting Instruments and Electrical Accessories shall be UL listed and labeled for use as theatrical lighting.
3. Contractor is responsible for insuring compliance with all applicable building, product, and installation codes (including but not limited to the IBC and NEC) that are in effect at the time of the installation. Corrections to any product, assembly or work performed under this contract to obtain code compliance shall be at contractor's expense.

4. Custom assemblies shall meet all applicable codes and where local jurisdictions require shall be inspected and approved by the local code authority at the Division 26 contractor's expense.
5. Lighting control equipment shall fully utilize, and control protocols and associated wiring shall conform, to the latest adopted version of the following ANSI standards:

    a. ANSI E1.11 DMX
    b. ANSI E1.20 Remote Device Management (RDM)
    c. ANSI E1.17 Architecture for Control Networks (ACN)
    d. ANSI E1.31 Streaming DMX on ACN

6. Custom field assemblies shall meet all applicable codes and where local jurisdictions require shall be inspected and approved by the local code authority at Division 26 installer’s expense.

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

A. The drawings and specifications are based on the products of one manufacturer; Electronic Theatre Controls (ETC). Equivalent products manufactured by others may be determined to be acceptable, subject to proper review by the Theatre Consultant, prior to bid date.

B. Since the drawings list the exact model numbers and functions of the Dimming and Control products of ETC, these specifications shall not include a detailed component description. The products listed on the drawings and schedules shall define the functions and specification requirements. It is the responsibility of the Contractor to ensure that the selected manufacturer makes themselves fully informed as to the performance, inter-equipment functionality and construction attributes of the listed product, in the event that the selected manufacturer is other than ETC.

C. Other manufacturers may submit for approval prior to the bid date in accordance with subparts 1.3 A. through 1.3 D. above.

D. The lighting control wiring topology shown on the TL drawings is based on ETC products. The Contractor shall confirm the lighting control wiring topology and cable types of any approved substitute manufacturer, prior to bid, and shall include such adjustments in his bid. The contractor shall maintain an accurate as-built wiring diagram of final system topology and cable types.

2.2 STAGE LIGHTING CONTROL – MAIN CONSOLE

A. The theatrical lighting console shall be one of the following products:

1. “Element 2-6K/6,144 outputs” as manufactured by Electronic Theatre Controls (ETC).
2. Or as prior approved

B. The principal features shall be as follows:

1. Lighting Console Desk
2. Dust Cover
3. Two 22” Multi-Touch Flat Panel Touch-Screen LCD Color Video Displays (1280x1024 min)
4. 32,768 control channels / 6,144 device addresses (minimum via DMX ports)
5. Two Console Worklights
6. USB 2.0 Flash Drive – one (1) gigabyte minimum capacity, preloaded with console offline editor software. Provide five (5).
7. Dust Cover for each 22” Flat Panel Touch-Screen.
8. Wireless Remote Focus equipment-ETCpad.
9. One Set each of Power and Data Cables, one at 10 feet and one at 25 feet in length with prewired connectors at each end, as required by console for proper operation.
10. Portable 1.5KVA, 120V true online UPS (set on floor under counter) with not less than (6) NEMA 5-15R fully protected outlets and 6 foot long input power cable and NEMA 5-15P plug.

2.3 CENTRAL LIGHTING CONTROL SERVER

A. The Architectural Control Server shall be the following product system:

1. Unison Paradigm Central Control Server (P-CCS) as manufactured by ETC, Inc.
2. Or as approved by Theatre Consultant prior to bid.

B. Mechanical

1. The Central Control Server (P-CCS) assembly shall be designed for use with Unison Paradigm Series Control Systems.
2. P-CCS electronics shall be contained in a single assembly.

    a. The assembly shall be housed in a formed steel body
    b. The server shall be fabricated of 16-gauge steel, finished in fine-texture, scratch-resistant, powder coat paint
    c. Mounting holes shall be provided for installation of a rack mount kit

3. User Interface

    a. The P-CCS power button shall be backlit for use in low-light conditions.

4. The P-CCS shall provide a Universal Serial Bus (USB) port on the front panel for transfer of configuration data.
5. The P-CCS shall provide rear-panel connections for (2) RJ45 jack for Ethernet connection to the processor for configuration, Virtual Touchscreen (VTS) and web-browser-based system access.
6. Architectural Lighting System configuration and program information shall be stored in solid state memory, which does not require battery backup.

    a. The P-CCS shall provide a hard drive for storage of system configurations.

C. Electrical

1. The P-CCS shall support 100-240VAC power input and utilize an external transformer power supply
2. The P-CCS shall allow for nearly silent operation
3. The server shall utilize microprocessor based, solid state technology to provide multi-processor lighting and building control
4. The server shall provide two IEE802.3u Ethernet connections for 100BASE-TX communication with the lighting control system

    a. The Primary Ethernet port shall be reserved for connection to the lighting control system
    b. The Secondary Ethernet connection shall be used for interface with BACnet IP enabled building systems
    c. Both Connections shall support Virtual Touchscreen (VTS) functionality

5. Following a loss of power, the P-CCS shall return to its previous power state upon power being restored

D. Environmental

1. The ambient operating temperature shall be 0° to 40°C (32° to 104°F)
2. The storage temperature shall be -40° to 70°C (-40° to 158°F)
3. The operating humidity shall be 5% - 95% non-condensing

E. Functional

1. Capacity

    a. Shall support up to 64 Paradigm Architectural Control Processors (ACP)
    b. Shall support up to 64 individual projects

2. System

    a. Shall support multi-user LiveControl and LiveEdit simultaneously
    b. System shall support the use of Network Time Protocol for real time clock synchronization
    c. System shall support remote firmware upload over an Ethernet connection from a connected PC running the LightDesigner software
    d. Failure of a single Processor shall not prohibit continuing operation of the remaining connected system
    e. Shall log system error messages using Syslog
    f. The server shall support ANSI E1.17 Architecture for Control Networks (ACN)
        1) Servers that do not support ANSI E1.17 shall not be acceptable
    g. The server shall support ANSI/ ASHRAE BSR135.1 BACnet IP protocol.
        1) Servers that do not support BSR135.1 shall not be acceptable

2.4 GENERAL CONTROL SYSTEM

A. Approved Products

1. ETC “Unison/Paradigm” ERn4, with PACP architectural control processor and SPM station power module.

B. Central Processor Unit

1. Mounted within Auxiliary Rack (See 2.5 below)
2. Manages all General Control System (GCS) stations for house lighting, work lighting and non-dims.
3. Manages selected DMX digital dimmer information on an input and output basis, up to (2) universes.
4. Can have its configuration data saved to or loaded from a USB thumb drive or SD card.
5. Shall be fully SACN interactive.
6. Shall have two programmable input for external Form C contact closures.

2.5 GENERAL CONTROL SYSTEM STATIONS

A. General control system remote stations shall be available with pushbuttons and/or linear potentiometers. There shall be a variety of standard stations. Custom or semi-custom stations shall be available from the factory. Stations shall be standard plate style, custom panel mount or portable style as identified on the drawings.

B. Stations shall have all functions programmable via software.

C. Custom labeling shall be furnished as required and detailed on the drawings.

D. Stations may be used for house lighting, worklighting or non-dims, as called out on the drawings.

E. Selected stations shall employ high-resolution, color graphic LCD touch screen technology. They shall be configurable via software and fully bi-directionally interactive with other elements of the GCS system. Stations shall be capable of wiring connection via either the GCS data bus, or via the Lighting Ethernet backbone.

F. Lighting Control Station Receptacles for Portable Stations (nicknamed “Smart Jacks”) shall have specialty receptacle elements mounted in a faceplate with finish matching other stations. These devices shall be intended for use with portable lighting control stations. Label each Smart Jack with the words “Lighting Portable”.

G. Occupancy Sensors shall be provided where shown on the TL drawings. Occupancy Sensors shall be configurable via software and fully bi-directional with other elements of the GCS system. Stations shall be capable of wiring connection via the GCS data bus.

2.6 LIGHTING SYSTEM AUXILIARY RACK

A. Provide an EIA 19 inch equipment rack with multiple networking and lighting control devices for use with the lighting control system. This device shall be appropriately listed and labeled as an assembly by a UL approved shop. The base cabinet shall be a hinged wall mount unit as manufactured by Middle Atlantic, DWR series. Provide vented, locking door.

B. The Auxiliary Rack shall contain but is not limited to:

1. Lighting Network Patch Bay
2. Lighting Network Patch Cable Management Tray
3. POE Network Switch(es)
4. DMX Distribution Hubs
5. General Control Processor (see 2.02 above)
6. UPS (true sine wave)
7. SACN Gateways (Net to DMX Bi-Directional)
8. Power outlet strip with feed cord & plug (not less than four NEMA 5-15R outlets) to be plugged into output of UPS as source. Run vertical at cabinet rear.
9. Plywood backplane or modular metal attachment ribs, finished black.

C. Approved Products: The Aux Rack assembly shall be fabricated by the manufacturer of the dimmer rack and GCS processor. Refer to TL drawings for specific information regarding all components and requirements.

2.7 DMX, ETHERNET JACKS AND LIGHTING NETWORK NODES

A. Devices “factory-integrated” in equipment provided under Section 260962

1. Various DMX Jacks and Lighting Network Nodes shall be factory integrated into equipment provided under Specification Section 26 09 62. Refer to the Control Device Schedule, Distribution Device Schedule and Lighting Control Interconnection Diagrams on TL series drawings.

B. Device Label Requirements

1. Refer to Control Device Schedule and Distribution Device Schedule shown on TL8 series sheets for device nomenclature.

C. DMX Input and Output Receptacle Stations

1. DMX input receptacle stations shall contain a 5-pin, flush mounted XLR male receptacle on the front side. The rear side shall have a circuit board and an RJ-45 female connector or Category-5 rated punch-down block prewired to front side receptacle. Provide with crimping pin-out instructions.
2. Provide permanent labeling at all DMX input receptacles; “DMX #X IN”, where “X” stands for the DMX universe number.
3. DMX output receptacle stations shall contain a 5-pin, flush mounted XLR female receptacle on the front side. The rear side shall have a circuit board and an RJ-45 female connector or Category-5 rated punch-down block prewired to front side receptacle. Provide with crimping pin-out instructions.

4. Provide permanent labeling at all DMX output receptacles: “DMX #X-Y OUT”, where “X” stands for the DMX universe number and “Y” stands for the DMX Splitter output number.
5. DMX receptacles shall have a black anodized aluminum plate.
6. DMX receptacles mounted in other control or distribution devices shall be panel mount type and shall be constructed similar to stand-alone units.
7. Provide plug-type DMX signal terminators, as scheduled, using matching 5 pin male XLR device and 120 ohm resistance in accordance with ESTA/USITT standards, where required in multi-device assemblies.
8. Refer to TL drawings for Receptacle Station locations and quantities.

D. RJ-45 Ethernet Receptacles for SACN Lighting Control

1. Provide RJ-45 Ethernet receptacles for lighting control system at locations shown on TL drawings.
2. Ethernet receptacle types vary by location. Refer to schedules on TL drawings for specific types and configuration.
3. All Ethernet receptacles for lighting control shall support Power Over Ethernet (PoE)
4. Do not connect Ethernet receptacles for lighting control system to hubs, routers or switches which are part of the general building Ethernet system unless specifically instructed to do so on the TL drawings.

E. Lighting Control System Network Nodes

1. Nodes shall be fabricated in both of two versions. Selected nodes shall have two ports, suitable for programmable configuration as dual-out, dual-in or singe-out/single-in combo for DMX universes. Selected nodes shall allow for up to four configurable ports.
2. Nodes shall be fabricated as flush rack mount, pipe mount and portable with Ethernet jack and cable. All 2-port Network nodes shall be Power over Ethernet configured for operating current and voltage.
3. Four-port node shall be powered externally and shall be located in the Lighting System Auxiliary Rack specified in 2.05 above.
4. Provide types and quantities as identified on TL drawings.
5. Approved Products: Acceptable products shall be as manufactured by ETC, or may be third party, but must include the complete and current firmware and software of the GCS system, under specific license.

2.8 RELAY CABINETS

A. General

1. The lighting control panel shall consist of 48 individual controllable relays.
2. Refer to TL drawings for application and interconnection of lighting controls.
3. Dimmer rack shall incorporate a central processor which can be remotely configured, and shall be fully SACN interactive.
4. All components and assembly shall be UL Listed and labeled as components and assemblies.
5. All relays shall be fully duty rated for no less than 20A continuous current at 120VAC.

B. Approved Manufacturers and Products: ETC Sensor IQ “Main Fed” Relay Panel. Refer to Drawings and Schedules for quantity and locations.
   1. Other manufacturers may submit for approval prior to bid in accordance with subparts 1.3A through 1.3D above.

2.9 CONTROL BOOTH AUXILIARY CONSOLETTE

A. System Description:

   1. The Auxiliary Consolette shall be a portable table top custom control unit with digital color touchscreen. Refer to TL drawings for details.
   2. The functionality of this portable control device shall be the same as its counterpart at the Stage Manager Panel.
   3. Provide with appropriate 30’-0” control cable and connector to plug into the “Net Jack” in the Main Control Booth, or for use at the House Control position.

B. Approved Products:

   1. ETC “Paradigm P-TS7-PE”
   2. Other manufacturers may submit for approval prior to the bid date in accordance with subparts 1.3 A. through 1.3 E. above.

2.10 DMX INTERFACE FOR EMERGENCY LIGHTING

A. Shall interface between LED lighting fixtures in Auditorium, which use a DMX signal for dimming and are set to be emergency egress fixtures.

B. Unit shall pass-thru normal DMX source during non-emergency times, and shall interrupt normal DMX stream and replace with its own emergency DMX data stream to designated emergency LED fixtures.

C. Refer to TL drawings for specific interconnection requirements.

D. Acceptable Product: ETC # DEBC and #EBDK, or prior approved substitute.

PART 3 - EXECUTION

3.1 GENERAL

A. The contractor shall coordinate with all other trades regarding placement and connection of equipment prior to installation of equipment.

B. Before installation work the contractor shall verify that approved shop drawings reflect the actual field requirements. Report any deviation between field conditions and shop drawings to the Architect in writing.

C. Manufacturer shall provide detailed and specific installation instructions to the Contractor for proper installation of the equipment.

D. Contractor shall provide all mounting hardware needed for proper installation of the equipment per manufacturer recommendations and requirements.

E. All deviations from the system design on the Contract Documents must be preceded by an approved RFI submission (from the Contractor) that has been reviewed by the Architect and the Theater Consultant. If deviations are found during a job observation visit or during punchlist site visit, the Theater Consultant and/or Architect may direct the Contractor to re-do the work to comply with the contract documents, at no additional cost to the Owner or Architect's design team, if said deviations are not the result of a directive issued in response to a timely submitted RFI.

3.2 INSTALLATION TEST AND ADJUSTMENTS

A. The lighting control system inclusive of the dimmers shall be tested and in complete operating order under terms of this Section of the Specification, as well as any requirements listed in the General Conditions.

B. The contractor shall provide a factory trained technician to test and commission the dimming and control system.

C. At the completion of the installation and control wiring terminations, the system shall be energized by the aforementioned trained factory technician. At this time the following tests shall be conducted:

1. Final Continuity Check and I.D. Verification of all load circuits.
2. Dimmer Operation - Each dimmer shall be tested individually with a minimum 75% load.
3. Documentation Verification - The contractor, in conjunction with representatives of both the Architect and Manufacturer, shall review the scope of work covered by this Section of the Specifications and, if necessary, create a "punch list" of items requiring correction. All corrections shall be made in a timely manner, to not lengthen the contract period nor interfere with daily activities of using agency.

D. Contractor shall direct lighting controls manufacturer to set curve, setpoints, smoothing and resolution of dimmer fade on all line voltage, digital and analog signal sourced circuits so that all fixtures perform a smooth emulation or actual square-law fade appearance tracking with each other, to the best degree possible, regardless of the mode used to dim individual lighting fixtures in theatre. Contractor shall provide directed management of coordination between lighting controls manufacturer and lighting fixture manufacturers. Contractor shall execute complete and detailed testing of all lighting control data wiring between control system and lighting fixtures, and between each lighting fixture, in accordance with ESTA and ANSI standards for DMX, RDM and ACN.

E. The Contractor shall be responsible for any and all corrections to the system that shall be made by the manufacturer and shall compensate the Theater Consultant for any time that is required to perform or coordinate the performance of services that are the responsibility of the contractor and or their subcontractors and vendors in the event that the subcontractor or vendors do not respond in a timely and appropriate fashion during the punchlist, closeout, testing, demonstration and warranty periods.

F. After receipt of the punchlist, the Contractor shall perform all work necessary to rectify the items on the punchlist. Once all items have been rectified, the Contractor shall notify the Architect in writing that the work is ready for backcheck of the punchlist. If during the onsite backcheck review, the Architect and/or Theater Consultant observe incomplete or incorrect items necessitating another punchlist and another backcheck, the Contractor shall provide compensation for all return site visits and time required to generate followup reports.

3.3 SYSTEM STARTUP, OWNER'S INSTRUCTIONS & COMMISSIONING

A. Operation Instruction:

1. Supply instruction to the Owner's operating personnel on operation and care of system for not less than sixteen hours total in 2 separate sessions. Instruction shall include, but not be limited to, proper general maintenance of the system, replacement procedures for user replaceable parts and operating procedure to obtain maximum usage of system.
2. Deliver all copies of approved Operations Manual to The Owner's Representative prior to first instruction session, and review it as part of that session.
3. The first session shall take place in the presence of the Owner's Representative or the Owner's Representative's sub-consultant, and shall occur directly after finish of Completion Checkout. If the Owner's Representatives judge that any work inspected fails to conform to the specification, or is not substantially complete at time of Completion Checkout, postpone instruction session until the Owner's Representatives judge the entire Lighting System to conform to specification.
4. The second session shall occur at a time arranged by the Owner's Representative no sooner than 1 day and no later than 1 month after first session.

B. Houselight Preset Programming

1. Contractor shall have an authorized factory technician configure the House light & Work light system configuration and preset programming in accordance with a Programming schedule prepared by the Theater Consultant. Programming Schedule shall be part of the contract documents and/or shall be confirmed at time of submittal review.
2. Deviations from the Programming Schedule that have not been pre-approved by the Theater Consultant in advance of system configuration shall be reset to those as specified, unless the deviations are shown to be critical to proper system function.

C. Owner Adaptation Adjustment Period

1. Contractor shall include allowance for (2) additional visits to adjust system software configuration, to allow for revisions due to adaptation and familiarization by the Owner's staff after occupation of the facility has been obtained, or due to adjustments requested by the Theater Consultant to optimize the original intended functionality.
2. The (2) additional visits defined herein shall be in addition to any visits mandated by punchlist or backpunch corrections to the published system configuration schedules prepared and submitted by the Theater Consultant.
3. Time period for these Adaptation Adjustment site visits shall be limited to:

    a. 3 months after Owner has taken beneficial occupancy of the facility, or
    b. 3 months after approval from the Theater Consultant that all related punchlist / backpunch items have been satisfied, or

c. 3 months after Owner has had continuous, normal scheduled use of the facility and the prior two conditions have also been met, or
d. Whichever of the three prior conditions is longer.

3.4 MAINTENANCE

A. Maintenance services

1. One year following date of final acceptance, a factory engineer shall be provided to examine, adjust and repair the equipment included in this section which is found to require warranty work prior to the end of the warranty period. This service shall not cover adjustments, repairs or replacement of parts due to negligence, misuse, abuse or accidents caused by persons other than the Manufacturer. All labor and materials which are required to perform this service shall meet or exceed these specifications and shall not compromise the performance of the equipment in any way.
2. Following this inspection and maintenance service, the Manufacturer shall provide the Owner and Theatre Consultant with a written report itemizing the results of the inspections and the warranty work, which was conducted. The Manufacturer shall also include in this written report recommendations for any corrective actions which the Manufacturer feels should be taken, with respect to the equipment included in this section, but are outside the scope of the warranty agreement.

B. Extra Materials:

1. Deliver stock of maintenance material to the Owner. Furnish the following to match those installed and taken from the same production run, packaged with protective covering for storage and identified with appropriate labels.

    a. Two spare dimmer modules for each type of dimmer/non-dim / constant module in the system.
    b. Provide one spare faceplate or complete internal components of each type of control device in the system (not including the GCS processor).
    c. One spare Ethernet node or complete internal components of each type of node in the system.
    d. Two circuit breakers of each size in the system.
    e. Provide a package of spare parts for all user serviceable portions of the dimmer and control systems and distribution apparatus.
    f. Provide 10% of total quantity of each type of small, replaceable component or part in system as spare parts (minimum of one).
    g. Label all spare parts with Manufacturer's part number, designation and description, and location(s) where used.
    h. Provide durable, clearly labeled, storage containers for all spare parts, including special static free containers for electronically sensitive parts.

3.5 WARRANTY

A. All major components shall carry a manufacturer’s and/or installer’s warranty, which shall guarantee against defects in materials and workmanship for a minimum period of two years. Refer to Division 01 for the start of the warranty period.

B. Warranty must include all shipping expenses including, but not limited to, return shipping of items which do not meet these specifications.

C. The warranty period shall not start until all punch list items have been rectified.

D. The Contractor shall warrant materials and workmanship of systems and equipment installed as free of defects. The Contractor shall guarantee in writing the repair or replacement within two calendar weeks for any item found defective during the warranty period. Ordinary wear and defects due to improper usage are not included.

E. During the warranty period, all emergency conditions where system failures may be hazardous or may cause severe hardship or cancellation of events and performances shall be responded to within 24 hours.

F. If start of warranty is delayed due to delay in contractor completing the punchlist items, and owner has commenced use of the facility, the Contractor shall provide the same level of service and responsibility defined herein.

3.6 PROJECT CLOSEOUT DOCUMENTS

A. System Drawings and Data Sheets

1. Provide at same size as original submittals, with all record data for as-built conditions.
2. Data sheets shall be keyed to TL drawings and submittals, similar to original submittal set.

B. Operation Manuals

1. For each equipment item, provide a printed and PDF file version of the current and matching Operation Manual.

C. Parts and Maintenance Manuals

1. For each equipment item, provide a printed and PDF file version of the current and matching Parts and Maintenance Manuals, clearly indicating part and ordering numbers for any and all Owner replaceable components.

D. Field and Factory Service Contact Information

1. Provide the contact information for warranty-based and post-warranty service support, both factory and local contacts at the time of project commissioning.
2. Include instructions as to proper service support contact protocol, indicating under what conditions the Owner should contact the factory, or the local support center.
3. Include the job number and copy of completed commissioning sign-off document.

E. System Configuration Record

1. Provide a USB thumb drive, marked as “GCS Final Configuration”, with a snapshot copy of the GCS configuration taken from the GCS processor at the time of system configuration sign-off by the Owner and/or Theater Consultant, post-training. Mark USB stick with snapshot date.

2. Provide a separate USB thumb drive, marked as “Lighting Network Configuration”, with a snapshot copy of the Lighting Network configuration taken from the Network gateways at the time of system configuration sign-off by the Owner and/or Theater Consultant, post-training. Mark USB stick with snapshot date.
3. Provide a separate USB thumb drive, marked as “Stage Lighting Console Configuration”, with a snapshot copy of the Stage Lighting Console configuration taken from the stage lighting console in the Auditorium at the time of system configuration sign-off by the Owner and/or Theater Consultant, post-training. Mark USB stick with snapshot date.
4. Provide a separate USB thumb drive, marked as “Dimmer Rack/Cabinet Processors Configurations”, with a snapshot copy of the Dimmer Rack/Cabinet Processors configurations taken from the Dimmer Rack/Cabinet Processors for the Auditorium at the time of system configuration sign-off by the Owner and/or Theater Consultant, post-training. Mark USB stick with snapshot date.
5. Additionally mark each stick with the name of the facility. All marking shall use durable adhesive labels or securely attached labeling disks.
6. Enclose all USB sticks in a heavy-wall plastic pouch, with holes and reinforcement for mounting in a 3-ring binder, with quick-zip enclosure.
7. Provide a duplicate copy of all sticks, with identical labeling, sent to the Theater Consultant’s primary office.

F. Warranty Document

1. Include an originally signed copy of all primary factory and OEM factory warranties in the project closeout package.

G. Deliver package to the Owner as part of the overall project closeout process.

1. Refer to Division 01 for general requirements.

END OF SECTION 260961

PART 1 - GENERAL

1.1 SUMMARY

A. Work Results: Furnish and install a complete package of Theater Lighting Distribution Devices for the Concert Hall.

B. Related Requirements: Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 General Requirement sections, apply to the work in this section.

1.2 PRICES AND PAYMENT PROCEDURES

A. Allowances: There are no allowance items in this section.

B. Unit Prices: There are no unit price requirements in this section.

C. Substitutions:

1. As required under Division 01, except where additional requirements are listed in this and other individual Sections referenced herein.
2. All bids shall be submitted based exactly on the contents and brand/models as specified of the TL drawings.
3. No product or device may be substituted without written authorization from the Theater/Assembly Space Consultant. TELEPHONE REQUESTS FOR APPROVAL WILL NOT BE ALLOWED. Only properly completed and signed CSI Substitution Request Forms with full technical catalog data sheets will be considered.
4. Pre-bid approval of substitute product manufacturers does not relieve the contractor and/or the product manufacturer from compliance with the functional and operational requirements of the Specifications. All products will be carefully evaluated during the submittal review process. If, at that time, any pre-bid approved substitute is found to be unsatisfactory and not in compliance, the contractor then must re-submit and supply the specified product(s) without additional costs to the Owner and/or delay to project.

D. If a manufacturer is listed in this section of the Specification as an approved equivalent, but no specific product model is listed, then the Contractor must submit complete factory technical data sheets and a Bill of Materials of the factory’s interpretation of equivalent product, along with their CSI request. Such submittal shall be handled in review as a pre-bid substitution request.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Rigging Battens for onstage Connector Strips are part of Division 11.

B. Refer to TR series Drawings for SOW cable coordination.

C. Project Meetings: Refer to Division 01 requirements.

D. Preconstruction Evaluation: Refer to Division 01 requirements.

E. Construction Documentation: Refer to Division 01 requirements.

F. Special Administrative Requirements: Refer to Division 01 requirements.

1.4 SUBMITTAL REQUIREMENTS

A. Submittals for Review: Product Data: Provide Manufacturer's Data / Specification Sheets and Bill of Materials cross-referenced to TL drawing Distribution and Control ID tags.

B. Shop Drawings: Provide detailed fabrication drawings for all Stage Lighting Distribution Devices, showing verified dimensions and attachment hardware. Show and call out all major components of each Device. Cross-reference all drawings to TL drawing Distribution and Control ID tags.

C. Samples: Refer to Distribution Device Schedule on TL series drawings for any specific sample requirements.

D. All submittal documents shall be clearly legible in 11x17 format. No exceptions.

E. Submittals for work of this specification section shall be integrated and coordinated with the submittal package and equipment in Section 26 09 61, and shall be submitted for review as one package at the same time.

1.5 REFERENCES

A. Abbreviations and Acronyms: Refer to TL0.1 for any special definitions related to this work

B. Definitions: Refer to TL0.1 for any special definitions related to this work

C. Reference Standards:

1. The following listed codes, standards, and regulations refer to the latest current edition and are to be considered a part of this Section: ASTM, AISC, NEC, NESC, NEMA, NFPA, UL, IEEE, ANSI, USITT, PLASA, ESTA, OSHA, and IBC.
2. All equipment where applicable standards have been established shall be listed and labeled by Underwriters Laboratories or other locally approved testing agency. All Lighting Instruments and Electrical Accessories shall be UL listed and labeled for use as theatrical lighting.
3. Contractor is responsible for insuring compliance with all applicable building, product, and installation codes (including but not limited to IBC, NEC, NEMA and UL) that are in effect at the time of the installation. Corrections to any product, assembly or work performed under this contract to obtain code compliance shall be at contractor's expense.
4. Custom assemblies shall meet all applicable codes and where local jurisdictions require shall be inspected and approved by the local code authority at the Division 26 installer's expense.
5. Custom field assemblies shall meet all applicable codes and where local jurisdictions require shall be inspected and approved by the local code authority at Division 26 installer's expense.

1.6 TEMPORARY FACILITIES AND CONTROLS

A. Temporary Use of Permanent Work: Refer to Division 01 requirements.

B. Additional to Division 01 requirements, use of devices provided under this section shall require the Division 26 contractor to replace, or clean and refurbish item(s) to “as new out of box” condition, if damaged during storage, installation or post-installation but prior to theater facility handoff to Owner.

1.7 INTEGRATION AND COORDINATION

A. Devices covered by this section of the specification may be fabricated by the approved manufacturers listed in each product-type subsection in Part 2 below. Due the fact that distribution devices are interrelated with dimming and control equipment specified in Section 26 09 61, the manufacturer of the dimming and control system shall be responsible for integration of the distribution devices into their total equipment package, even if the devices are fabricated by a separate, approved manufacturer.

B. The shop drawings/submittals for distribution devices shall be integrated and coordinated with the shop drawings/submittals for the dimming and controls and submitted together as one submittal package by the dimming and control manufacturer in Section 260961.

PART 2 - PRODUCTS

2.1 SUMMARY

A. Power outlet distribution devices specifically designed and tested for use with theatrical lighting fixtures and lighting accessories.

2.2 RELATED PRODUCTS

A. Section 26 09 61 – Production Venue Lighting Controls

2.3 SOURCE

A. Product Options – All options are specified in each device type sub-section below.

B. Substitution Limitations – No substitutions shall be allowed. All acceptable manufacturers are listed in each device type subsection below.

C. Source Qualifications – Not less than 5 years’ experience manufacturing theatrical lighting distribution devices which are listed and labeled accordingly by a nationally recognized testing laboratory.

D. Source Listing – Acceptable Manufacturers vary on an item basis. Refer to each Device type sub-section below.

2.4 PRODUCT SCHEDULE - Refer to TL drawings for Distribution Devices

2.5 PIPE MOUNTED PLUGGING BOXES

A. These units shall be multi-gang wiring devices designed for ease of installation and use as pipe mount outlet boxes.

B. Each unit shall consist of a code gauge steel back box and cover plate. All steel components shall be properly primed and finished with flat black enamel paint. Extruded heavy-wall aluminum is an acceptable alternate.

C. The receptacles shall be types and quantities as listed on the Distribution Device schedules and shown in details on the TL drawings. All receptacles shall be three pole grounding type.

D. All receptacles shall be clearly labeled with at least a one inch high circuit identification number.

E. Any wiring internal to the plugging box shall be rated at 125 degrees C, in accordance with the NEC and Underwriter's Laboratories.

F. Pipe mounted plugging boxes shall include two U-bolts with nuts and washers and flanges drilled for either 1.25" or 1.5" ID schedule 40 pipe. NOTE: CRITICAL MOUNTING POSITION OF U-BOLTS

G. Provide Stagecraft Industries, ETC, SSRC, or Performance Electric plugging boxes as detailed or listed in Distribution Equipment Schedules on TL drawings. All units shall conform to the applicable codes and shall be listed and labeled by an approved testing authority.

2.6 SURFACE OR FLUSH MOUNTED PLUGGING BOXES

A. These units shall be multi-gang wiring devices designed for ease of installation and use as surface or flush mount plugging boxes.

B. Each unit shall consist of a code gauge steel backbox and cover plate. All steel components shall be properly primed and finish with a flat black enamel paint. Extruded heavy-wall aluminum is an acceptable alternate.

C. The receptacles shall be types and quantities as listed on the Distribution Device schedules and shown in details on the TL drawings. All receptacles shall be three pole grounding type.

D. All receptacles shall be clearly labeled with at least a one inch high circuit identification number.

E. Any wiring internal to the plugging box shall be rated at 125 degrees C, in accordance with the NEC and Underwriter's Laboratories.

F. Surface mounted plugging boxes shall include a cover with edges turned back to the sides not less than ½ inch. Flush mounted plugging boxes shall include an overlapping flat cover, with overlap not less than 1 inch on each side for finished appearance on architectural surfaces.

G. Pipe Mounted plugging boxes shall include factory integrated pipe mounting brackets and U-Bolt mounting kits. All requirements listed in paragraph F. above shall apply to pipe mounted plugging boxes. See details on TL drawings for acceptable means.

H. Provide Stagecraft Industries, ETC, SSRC, or Performance Electric plugging boxes as detailed or listed in Distribution Equipment Schedules on TL drawings. All units shall conform to the National Electrical Code and shall be U.L. listed and labeled

2.7 STAGE FLOOR POCKETS

A. The floor pockets shall be a wiring device designed specifically to be permanently flush mounted in the sprung stage floor. Floor pocket enclosure shall be designed to allow early installation of backbox with insert plate and cover to be installed later in the project. In order to compensate for construction deviations, the floor pocket shall automatically compensate for floor framing variations in depth, without changing the distance between the cover and the insert plate.

B. The floor pocket cover shall be constructed of cast iron or aluminum. The plate shall contain recessed mounting holes to secure plate to stage floor. The floor pocket assembly shall be designed so that the lid plate and device panel shall ‘float’ relative to the backbox to accommodate placement in sprung stage floors. When not in use the door shall be self-closing and provide a flush clean floor surface. Cover must be de-burred and buffed smooth to prevent injury to cables or personnel. Cover must be strong enough to withstand the leg weight of a full size acoustic shell tower and/or concert grand piano.

C. The cover shall be constructed with integral hinges and cable holes. Secured inside shall be a sheet steel mounting plate for the receptacles.

D. The floor pocket back box shall be constructed of code gauge steel and shall be sized according to the number of conductors required for the receptacles. Knockouts shall be provided in the back box for contractor connection. The back box finish shall be flat black enamel, with rust resistant primer suitable for embedding in concrete.

E. The receptacles shall be flush mounted in the internal receptacle plate. All power receptacles shall be three pole grounding type. Refer to TL drawings for exact types.

F. Selected floor pockets shall have data outlets. Provide code required metal barrier. Data outlets shall mount flush in the inner plate.

G. Provide ETC, SSRC, or Performance Electric floor pockets as detailed or listed in Distribution Equipment Schedules on TL drawings. All units shall conform to the National Electrical Code and shall be U.L. listed and labeled.

2.8 DELIVERY, STORAGE AND HANDLING

A. Do not deliver Theater Lighting Distribution Devices until immediately prior to the point building is ready for their installation.

B. Protect from damage during delivery, handling, and storage.

C. Inspect all components in their original shipping cartons and packing to discover damage. Immediately process damage claim and replacement of equipment so as to not delay project.

D. Protect devices from damage by dust, dirt, and the work of all other trades.

2.9 FIELD SAMPLES /MOCKUPS

A. If requested by Architect, provide samples of Theater Lighting Distribution Devices which match the devices as specified herein.

2.10 LOCATIONS SCHEDULES

A. Refer to TL drawings for locations.

PART 3 - EXECUTION

3.1 INSTALLATION / APPLICATION / ERECTIONS / PLACEMENT

A. Coordinate placement of Theater Lighting Distribution Devices with catwalk framing to minimize blockage of stage lighting positions. Do not run conduit in catwalk openings such that it interferes with stage lighting fixture placement and positions. Refer to catwalk details on Architectural and TL drawings.

3.2 CONSTRUCTION WASTE MANAGEMENT

A. Dispose of all packing materials in accordance with General Requirements.

3.3 SITE QUALITY CONTROL

A. Site Testing and Inspections

1. Test circuit continuity of all Theater Lighting Distribution Devices.
2. Confirm that circuit ID labels match the actual source ID.

B. CLOSEOUT ACTIVITIES

1. Cleaning: Remove construction dust and debris from enclosures and outlet terminals immediately prior to facility turn-over to Owner.
2. Protection: Protect all devices from overspray of paint and other building applied materials.
3. Demonstration: Demonstrate proper use of devices and device accessories.
4. Training: Provide training to Owner’s designated personnel regarding proper use, care, and maintenance of Theater Lighting Distribution Devices and related accessories.

3.4 WARRANTY

A. All major components shall carry a manufacturer's and/or installer's warranty, which shall guarantee against defects in materials and workmanship for a period of two years. Refer to Division 01 for the start of the warranty period.

B. Warranty must include all shipping expenses including, but not limited to, return shipping of items which do not meet these specifications.

C. The warranty period shall not start until all punch list items have been rectified.

D. The Contractor shall warrant materials and workmanship of systems and equipment installed as free of defects. The Contractor shall guarantee in writing the repair or replacement within two calendar weeks for any item found defective during the warranty period. Ordinary wear and defects due to improper usage are not covered.

E. During the warranty period, all emergency conditions where system failures may be hazardous or may cause severe hardship or cancellation of events and performances shall be responded to within 24 hours.

F. If start of warranty is delayed due to delay in contractor completing the punchlist items, and owner has commenced use of the facility, the Contractor shall provide the same level of service and responsibility defined herein.

END OF SECTION 260962

PART 1 - GENERAL

1.1 SUMMARY

A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 - General Requirements sections, apply to the work specified in this Section.

B. Under Division 26, the Contractor shall provide all appropriate equipment installation, electrical conduit, wireway, standard backboxes, line and low voltage wire and terminations required for the equipment furnished under the following specification section:

1. Section 12 61 13 Fixed Audience Seating (Aisle lights)

C. The Contractor shall note that the work of the section covers the wiring, conduit and connection for equipment items that are supplied under other sections or divisions of the specification.

D. This work is in addition to other theatrical systems specified in Division 26.

1.2 WORK INCLUDED

A. Under Division 26, the Contractor shall furnish and install electrical conduit, back boxes, transformers, line voltage and low voltage wire and terminations, unless otherwise specified, as required for the electrical devices listed in other divisions, related to the concert hall. Refer to Architectural, Electrical, and TS drawings.

1.3 SUBMITTALS

A. Prior to fabrication, the specialty stage equipment specialist (defined in Section 11 61 60) will provide complete, detailed shop drawings and diagrams of all “electrified” stage rigging hoist motor (if any) and related control units. Upon approval, the Division 26 installer will be issued copies of these documents for coordination with his own work and with the work of all other relevant trades.

PART 2 - PRODUCTS

2.1 MATERIALS

A. All materials required for this work shall conform to the requirements for Division 26.

PART 3 - EXECUTION

3.1 SITE CONDITIONS

A. Coordinate work with all other trades in accordance with the Specifications, and with established trade criteria and applicable code requirements.

B. The Contractor shall ensure equipment furnished under Division 11 that requires work under Division 26, shall be delivered to jobsite in a timely manner.

3.2 SUPERVISION

A. Under Division 26, the Contractor shall coordinate with the supervisor of the specialty stage equipment fabricator/ installer (defined in Section 11 61 60) when and as needed during the execution of the work covered under this section of the specifications, for the installation and wiring of the equipment furnished by the specialty stage equipment fabricator/ installer and shown on the TR drawings.

3.3 TESTS AND INSPECTIONS

A. Under Division 26, the Contractor shall be on-site and available during the final testing process as outlined for the systems covered by this section and shown TS drawings.

END OF SECTION 260999

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following types of dry-type transformers rated 600 V and less.

1.2 SUBMITTALS

A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Wiring Diagrams: Power, signal, and control wiring.

C. Manufacturer Seismic Qualification Certification: Submit certification that transformers, accessories, and components will withstand seismic forces. Include the following:
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
      a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
      b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.3 QUALITY ASSURANCE

A. Source Limitations: Obtain each transformer type through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

1.4 DELIVERY, STORAGE, AND HANDLING

A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

1.5 COORDINATION

A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Tierney.
2. Eaton Electrical Inc.; Cutler-Hammer Products.
3. Federal Pacific Transformer Company; Division of Electro-Mechanical Corp.
4. General Electric Company.
5. Siemens Energy & Automation, Inc.
6. Square D; Schneider Electric.

2.2 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

B. Cores: Grain-oriented, non-aging silicon steel.

C. Coils: Continuous windings without splices except for taps.
1. Internal Coil Connections: Brazed or pressure type.
2. Coil Material: Aluminum or Copper.

2.3 DISTRIBUTION TRANSFORMERS

A. Comply with NEMA ST 20, and list and label as complying with UL 1561.

B. Cores: One leg per phase.

C. Enclosure: Ventilated, NEMA 250, Type 2.
1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

D. Transformer Enclosure Finish: Comply with NEMA 250.

E. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.

F. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.

G. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 150 deg C rise above 40 deg C ambient temperature.

H. K-Factor Rating 13: Transformers shall be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.
1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.
2. Indicate value of K-factor on transformer nameplate.

I. Enerty Efficiency: Transformer shall meet DOE2016 and Washington State Energy Code for energy efficiency.

J. Low-Sound-Level Requirements: Maximum sound levels, when factory tested according to IEEE C57.12.91, as follows:
1. 9 kVA and Less: 36 dBA
2. 30 to 50 kVA: 36 dBA
3. 51 to 150 kVA: 36 dBA
4. 151 to 300 kVA: 36 dBA
5. 301 to 500 kVA: 42 dBA

K. Mount transformers on vibration pads similar to Korfund or equal.

2.4 ISOLATION TRANSFORMER

A. Comply with NEMA ST 20, and list and label as complying with UL 1561.

B. Cores: One leg per phase.

C. Enclosure: Ventilated, NEMA 250, Type 2.
1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

D. Transformer Enclosure Finish: Comply with NEMA 250.

E. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.

F. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 150 deg C rise above 40 deg C ambient temperature.

G. K-Factor Rating 20: Transformers shall be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.

1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.
2. Indicate value of K-factor on transformer nameplate.

H. Energy Efficiency: Transformer shall meet DOE2016 and Washington State Energy Code for energy efficiency.

I. Low-Sound-Level Requirements: Maximum sound level shall be 36 dB

J. Faraday Shield

K. Mount transformers on vibration pads similar to Korfund or equal.

2.5 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic or metal nameplate for each transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

2.6 SOURCE QUALITY CONTROL

A. Test and inspect transformers according to IEEE C57.12.91.

B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.

1. Brace wall-mounting transformers as specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems.

B. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions and seismic codes applicable to Project.

3.3 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Bond neutral to ground per NEC separately derived systems.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:
1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

C. Remove and replace units that do not pass tests or inspections and retest as specified above.

D. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.5 ADJUSTING

A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.6 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 262200

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Existing Main Switchboard – Add 800 amp breaker, bus kit, bus extension as required for a fully UL listed bus extension.

1.2 SUBMITTALS

A. Shop Drawings shall indicate front and side enclosure elevations with overall dimensions shown; conduit entrance locations and requirements; nameplate legends; one-line diagrams; equipment schedule; and switchboard instrument details.

1.3 QUALIFICATIONS

A. To be considered for approval, a manufacturer shall have specialized in the manufacturing and assembly of switchboards for at least fifty (50) years.

B. Furnish products listed by Underwriters Laboratories Incorporated and in accordance with standards listed in Article 1.03 - References.

C. The manufacturing facility shall be registered by Underwriters Laboratories Inc. to the International Organization for Standardization ISO 9002 Series Standards for quality.

1.4 MAINTENANCE MATERIALS

A. Provide installation and maintenance instructions with each switchboard. Instructions are to be easily identified and affixed within the incoming or main section of the line-up.

1.5 WARRANTY

A. Manufacturer shall warrant equipment to be free from defects in materials and workmanship for the lesser of one (1) year from date of installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Existing equipment is Square D. New equipment shall be Square D Company

2.2 BREAKER

A. Group mounted circuit breakers through 1200A

1. Circuit breaker(s) shall be group mounted plug-on with mechanical restraint on a common pan or rail assembly.
2. The interior shall have three flat bus bars stacked and aligned vertically with glass reinforced polyester insulators laminated between phases. The molded polyester insulators shall support and provide phase isolation to the entire length of bus.
3. Circuit breaker(s) equipped with line terminal jaws shall not require additional external mounting hardware. Circuit breaker(s) shall be held in mounted position by a self-contained bracket secured to the mounting pan by fasteners. Circuit breaker(s) of different frame sizes shall be capable of being mounted across from each other.
4. Line-side circuit breaker connections are to be jaw type.
5. All unused spaces provided, unless otherwise specified, shall be fully equipped for future devices, including all appropriate connectors and mounting hardware.
6. Thermal magnetic molded case circuit breakers through 2500A.
    a. Molded case circuit breakers shall have integral thermal and instantaneous magnetic trip in each pole.
    b. Circuit protective devices shall be Square D molded case circuit breaker(s). Circuit breaker(s) shall be [standard interrupting] [high interrupting] [extra high interrupting] [true current limiting*]. Ampere ratings shall be as shown on the drawings.
    * Manufacturer shall submit one set of published Ip and I^2t let-through curves (as required by UL) to the owner.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install breaker in accordance with manufacturer's written guidelines, the NEC, and local codes. Engage factory technician as required.

3.2 FIELD QUALITY CONTROL

A. Inspect completed installation for physical damage, proper alignment, anchorage, and grounding. Check tightness of accessible bolted bus joints using calibrated torque wrench per manufacturer's recommended torque values.

3.3 ADJUSTING

A. Adjust all operating mechanisms for free mechanical movement per manufacturers specifications. Tighten bolted bus connections in accordance with manufacturer's instructions.

3.4 CLEANING

A. Touch up scratched or marred surfaces to match original finish.

END OF SECTION 262413

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Distribution Panelboards – Provide power panel for distribution boards shown on the drawings.

B. Panelboard - Furnish and install lighting and appliance panelboard(s) as specified herein and where shown on the associated drawings.

C. Contractor shall note that drawings show shared neutrals for circuits. Contractor shall comply with NEC 210.4B, which requires either separate neutrals or a disconnecting means that disconnects all ungrounded conductors at the point where the circuit originates. This requires the contractor to provide breaker ties or 3 pole breakers for all groups of 3 circuits run with shared neutral in the field as grouping is frequently changed. Contractor shall include this in the contract. No additional payments will be made for this code requirement.

D. See section 260573 for protective device coordination study requirements. All equipment specified herein shall comply with the requirements of 260573. All equipment shall be increased in size, electronic trip added, wire and conduit size increased as require to provide a complete selectively coordinated system. Nothing in the following specification relieves the contractor from providing a complete selectively coordinated system. Fuses shall not be used to provide selective coordination. The coordination study (260573) shall be completed and stamped by the coordination engineering and all changes incorporated into the panel and gear prior to submitting for approval. All equipment shall take into account all requirements of the coordination study.

1.2 REFERENCES

The panelboard(s) and circuit breaker(s) referenced herein are designed and manufactured according to the latest revision of the following specifications.

A. NEMA PB 1 – Panelboards

B. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.

C. NEMA AB 1 - Molded Case Circuit Breakers

D. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)

E. UL 50 - Enclosures for Electrical Equipment

F. UL 67 – Panelboards

G. UL 98 - Enclosed and Dead-front Switches

H. UL 489 - Molded-Case Circuit Breakers and Circuit Breaker Enclosures

I. CSA Standard C22.2 No. 29-M1989 - Panelboards and Enclosed Panelboards

J. CSA Standard C22.2 No. 5-M91 - Molded Case Circuit Breakers

K. Federal Specification W-P-115C - Type I Class 1

L. Federal Specification W-C-375B/Gen - Circuit Breakers, Molded Case, Branch Circuit And Service.

M. NFPA 70 - National Electrical Code (NEC)

N. ASTM - American Society of Testing Materials

1.3 SUBMITTAL AND RECORD DOCUMENTATION

A. Approval documents shall include drawings. Drawings shall contain overall panelboard dimensions, interior mounting dimensions, and wiring gutter dimensions. The location of the main, branches, and solid neutral shall be clearly shown. In addition, the drawing shall illustrate one line diagrams with applicable voltage systems.

1.4 QUALIFICATIONS

A. Company specializing in manufacturing of panelboard products with a minimum of fifty (50) years documented experience.

B. Panelboards shall be manufactured in accordance with standards listed Article 1.2 - REFERENCES.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Inspect and report concealed damage to carrier within their required time period.

B. Handle carefully to avoid damage to panelboard internal components, enclosure, and finish.

C. Store in a clean, dry environment. Maintain factory packaging and, if required, provide an additional heavy canvas or heavy plastic cover to protect enclosure(s) from dirt, water, construction debris, and traffic.

1.6 OPERATIONS AND MAINTENANCE MATERIALS

A. Manufacturer shall provide installation instructions and NEMA Standards Publication PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.

1.7 WARRANTY

A. Manufacturer shall warrant specified equipment free from defects in materials and workmanship for the lesser of one (1) year from the date of installation or eighteen (18) months from the date of purchase.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Shall be Square D Company, General Electric, Eaton/Westinghouse or Siemens.

B. Substitutions must be submitted in writing three weeks prior to original bid date with supporting documentation demonstrating that the alternate manufacturer meets all aspects of the specification herein.

2.2 480Y/277 VOLT PANELBOARD

A. NF
1. Interior
a. Shall be type NF panelboard for 480Y/277 Vac maximum. Continuous main current ratings, as indicated on associated drawings, not to exceed 600 amperes maximum for main breaker panelboards and not to exceed 800 amperes for main lug panelboards.
b. Minimum Short Circuit Rating: As shown on drawings. Minimum size shall be 14,000 AIC rms symmetrical amperes at 480Y/277 Vac.
c. Provide one (1) continuous bus bar per phase. Each bus bar shall have sequentially phased branch circuit connectors limited to bolt-on branch circuit breakers. The bussing shall be fully rated. Panelboard bus current ratings shall be determined by heat-rise tests conducted in accordance with UL 67. Bussing rated 100-400 amperes shall be plated copper or aluminum. Bussing rated for 600 and 800 amperes shall be plated copper as standard construction. Bus bar plating shall run the entire length of the bus bar. Panelboards shall be suitable for use as Service Equipment when application requirements comply with UL 67 and NEC Articles 230-F and -G.
d. All current-carrying parts shall be insulated from ground and phase-to-phase by high dielectric strength thermoplastic.
e. A solidly bonded copper equipment ground bar shall be provided.
f. Split solid neutral shall be plated and located in the mains compartment up to 250 amperes so all incoming neutral cable may be of the same length.
g. Interior trim shall be of dead-front construction to shield user from energized parts. Dead-front trim shall have pre-formed twistouts covering unused mounting space.
h. Nameplates shall contain system information and catalog number or factory order number. Interior wiring diagram, neutral wiring diagram, UL Listed label and short circuit current rating shall be displayed on the interior or in a booklet format.
i. Interiors shall be field convertible for top or bottom incoming feed. Main circuit breakers in 125A interiors shall be vertically mounted. Main circuit breakers over 125A shall be vertically mounted. Sub-feed circuit breakers shall be vertically mounted. Main lug interiors up to 400 amperes shall be field convertible to main

breaker. Interior leveling provisions shall be provided for flush mounted applications.

j. Interior phase bus shall be pre-drilled to accommodate field installable options. (i.e., Sub-Feed Lugs, Sub-Feed Breakers, Thru-Feed Lugs)

k. Interiors shall accept 125 ampere breakers in group mounted branch construction.

2. Main Circuit Breaker (where shown)
   a. Shall be Square D type circuit breakers.
   b. Main circuit breakers shall have an overcenter, trip-free, toggle mechanism which will provide quick-make, quick-break contact action. Circuit breakers shall have a permanent trip unit with thermal and magnetic trip elements in each pole. Each thermal element shall be true rms sensing and be factory calibrated to operate in a 40° C ambient environment. Thermal elements shall be ambient compensating above 40° C.
   c. Two- and three-pole circuit breakers shall have common tripping of all poles. Circuit breakers frame sizes above 100 amperes shall have a single magnetic trip adjustment located on the front of the breaker that allows the user to simultaneously select the desired trip level of all poles. Circuit breakers shall have a push-to-trip button for maintenance and testing purposes.
   d. Circuit breaker handle and faceplate shall indicate rated ampacity. Standard construction circuit breakers shall be UL Listed for reverse connection without restrictive line or load markings.
   e. Circuit breaker escutcheon shall have international I/O markings, in addition to standard ON/OFF markings. Circuit breaker handle accessories shall provide provisions for locking handle in the ON or OFF position.
   f. Lugs shall be UL Listed to accept solid or stranded copper and aluminum conductors. Lugs shall be suitable for 90° C rated wire, sized according to the 75° C temperature rating per NEC Table 310-16. Lug body shall be bolted in place; snap-in designs are not acceptable.
   g. The circuit breakers shall be UL Listed for use with the following accessories: Shunt Trip, Under Voltage Trip, Ground Fault Shunt Trip, Auxiliary Switch, Alarm Switch, Mechanical Lug Kits, and Compression Lug Kits.
3. Branch Circuit Breakers
   a. Shall be Square D type circuit breakers. Circuit breakers shall be UL Listed with amperage ratings, interrupting ratings, and number of poles as indicated on the drawings.
   b. Molded case branch circuit breakers shall have bolt-on type bus connectors.
   c. Circuit breakers shall have an overcenter toggle mechanism which will provide quick-make, quick-break contact action. Circuit breakers shall have thermal and magnetic trip elements in each pole. Two- and three-pole circuit breakers shall have common tripping of all poles.
   d. There shall be two forms of visible trip indication. The circuit breaker handle shall reside in a position between ON and OFF. In addition, there shall be a red VISI-TRIP® indicator appearing in the clear window of the circuit breaker housing.
   e. The exposed faceplates of all branch circuit breakers shall be flush with one another.
   f. Lugs shall be UL Listed to accept solid or stranded copper and aluminum conductors. Lugs shall be suitable for 90° C rated wire, sized according to the 75° C temperature rating per NEC Table 310-16.
   g. Breakers shall be UL Listed for use with the following factory installed accessories: Shunt Trip, Auxiliary Switch, and Alarm Switch.
   h. Breaker shall be UL Listed with the following ratings: (15-125A) Heating, Air Conditioning, and Refrigeration (HACR), (15-30A) High Intensity Discharge (HID), and (15-20A) Switch Duty (SWD)
4. Enclosures

a. Type 1 Boxes
   1) Boxes shall be galvanized steel constructed in accordance with UL 50 requirements. Galvannealed steel will not be acceptable.
   2) Boxes shall have removable endwalls with knockouts located on one end. Boxes shall have welded interior mounting studs. Interior mounting brackets are not required.
   3) Box width shall not exceed 26” wide.

b. Type 1 Fronts
   1) Front shall meet strength and rigidity requirements per UL 50 standards. Shall have ANSI 49 gray enamel electrodeposited over cleaned phosphatized steel.
   2) Fronts shall be hinged 1-piece with door (door in door). Mounting shall be as indicated on associated drawings.
   3) Panelboards rated 250 amperes and below shall have MONO-FLAT fronts with concealed door hinges and trim screws. Front shall not be removable with the door locked. Panelboards rated above 250 amperes shall have vented fronts with concealed door hinges. Doors on front shall have rounded corners; edges shall be free of burrs.
   4) Front shall have flat latch type lock with catch and spring loaded stainless steel door pull. All lock assemblies shall be keyed alike. One (1) key shall be provided with each lock. A clear plastic directory card holder shall be mounted on the inside of door.

c. Type 3R, 5, and 12 where indicated.
   1) Enclosures shall be constructed in accordance with UL 50 requirements. Enclosures shall be painted with ANSI 49 gray enamel electrodeposited over cleaned phosphatized steel.
   2) All doors shall be gasketed and equipped with a tumbler type vault lock and two (2) additional quarter turn fasteners on enclosures 59 inches or more in height. All lock assemblies shall be keyed alike. One (1) key shall be provided with each lock. A clear plastic directory card holder shall be mounted on the inside of door.
   3) Maximum enclosure dimensions shall not exceed 21” wide and 9.5” deep.

2.3 208/120 VOLT VOLT PANELBOARD

A. NQ
   1. Interior
      a. Shall be type NQ panelboard rated for 240 Vac/48 Vdc maximum. Continuous main current ratings, as indicated on associated drawings, not to exceed 600 amperes maximum.
      b. Minimum short circuit current rating: as shown on drawings but minimum 10,000 in rms symmetrical amperes at 240 Vac.
      c. Provide one (1) continuous bus bar per phase. Each bus bar shall have sequentially phased branch circuit connectors suitable for plug-on or bolt-on branch circuit breakers. The bussing shall be fully rated. Panelboard bus current ratings shall be determined by heat-rise tests conducted in accordance with UL 67. Bussing rated 100-400 amperes shall be plated copper or aluminum. Bussing rated for 600 amperes shall be plated copper as standard construction. Bus bar plating shall run the entire length of the bus bar. Panelboards shall be suitable for use as Service Equipment when application requirements comply with UL 67 and NEC Articles 230-F and -G.
      d. All current-carrying parts shall be insulated from ground and phase-to-phase by high dielectric strength thermoplastic.

e. A solidly bonded copper equipment ground bar shall be provided. An additional copper isolated/insulated ground bar shall also be provided mounted on insulators.
f. Split solid neutral shall be plated and located in the mains compartment up to 225 amperes so all incoming neutral cable may be of the same length. Where indicated UL Listed panelboards with 200% rated solid neutral shall be plated copper for non-linear load applications. Panelboards shall be marked for non-linear load applications.
g. Interior trim shall be of dead-front construction to shield user from energized parts. Dead-front trim shall have pre-formed twistouts covering unused mounting space.
h. Nameplates shall contain system information and catalog number or factory order number. Interior wiring diagram, neutral wiring diagram, UL Listed label and short circuit current rating shall be displayed on the interior or in a booklet format.
i. Interiors shall be field convertible for top or bottom incoming feed. Main circuit breakers in 100A interiors shall be vertically mounted. Main circuit breakers over 100A shall be vertically mounted. Sub-feed circuit breakers shall be vertically mounted. Main lug interiors up to 400 amperes shall be field convertible to main breaker. Interior leveling provisions shall be provided for flush mounted applications.

2. Main Circuit Breaker where indicated.
   a. Shall be Square D type circuit breakers.
   b. Main circuit breakers shall have an overcenter, trip-free, toggle mechanism which will provide quick-make, quick-break contact action. Circuit breakers shall have a permanent trip unit with thermal and magnetic trip elements in each pole. Each thermal element shall be true rms sensing and be factory calibrated to operate in a 40° C ambient environment. Thermal elements shall be ambient compensating above 40° C.
   c. Two- and three-pole circuit breakers shall have common tripping of all poles. Circuit breakers frame sizes above 100 amperes shall have a single magnetic trip adjustment located on the front of the circuit breaker that allows the user to simultaneously select the desired trip level of all poles. Circuit breakers shall have a push-to-trip button for maintenance and testing purposes.
   d. Breaker handle and faceplate shall indicate rated ampacity. Standard construction circuit breakers shall be UL Listed for reverse connection without restrictive line or load markings.
   e. Circuit breaker escutcheon shall have international I/O markings, in addition to standard ON/OFF markings. Circuit breaker handle accessories shall provide provisions for locking handle in the ON or OFF position.
   f. Lugs shall be UL Listed to accept solid or stranded copper and aluminum conductors. Lugs shall be suitable for 90° C rated wire, sized according to the 75° C temperature rating per NEC Table 310-16. Lug body shall be bolted in place; snap-in designs are not acceptable.
   g. The circuit breakers shall be UL Listed for use with the following accessories: Shunt Trip, Under Voltage Trip, Ground Fault Shunt Trip, Auxiliary Switch, Alarm Switch, Mechanical Lug Kits, and Compression Lug Kits.
3. Branch Circuit Breakers
   a. Shall be Square D type circuit breakers. Circuit breakers shall be UL Listed with amperage ratings, interrupting ratings, and number of poles as indicated on the associated drawings.
   b. Molded case branch circuit breakers shall have bolt-on type bus connectors.
   c. Circuit breakers shall have an overcenter toggle mechanism which will provide quick-make, quick-break contact action. Circuit breakers shall have thermal and magnetic trip elements in each pole. Two- and three-pole circuit breakers shall have common tripping of all poles.

d. There shall be two forms of visible trip indication. The breaker handle shall reside in a position between ON and OFF.
e. The exposed faceplates of all branch circuit breakers shall be flush with one another.
f. Lugs shall be UL Listed to accept solid or stranded copper and aluminum conductors. Lugs shall be suitable for 90° C rated wire, sized according to the 75° C temperature rating per NEC Table 310-16.
g. Breakers shall be UL Listed for use with the following factory installed accessories: Shunt Trip, Auxiliary Switch, and Alarm Switch.

4. Enclosures
   a. Type 1 Boxes
      1) Boxes shall be galvanized steel constructed in accordance with UL 50 requirements. Galvannealed steel will not be acceptable.
      2) Boxes shall have removable endwalls with knockouts located on one end. Boxes shall have welded interior mounting studs. Interior mounting brackets are not required.
      3) Box width shall be 20” wide maximum unless approved.
   b. Type 1 Fronts
      1) Front shall meet strength and rigidity requirements per UL 50 standards. Front shall have ANSI 49 gray enamel electrodeposited over cleaned phosphatized steel.
      2) Fronts shall be hinged 1-piece with door (door in door). Mounting shall be as indicated on associated drawings.
      3) Panelboards shall have MONO-FLAT fronts with concealed door hinges and mounted with trim screws. Front shall not be removable with the door locked. Doors on front shall have rounded corners and edges shall be free of burrs.
      4) Front shall have cylindrical tumbler type lock with catch and spring-loaded stainless steel door pull. All lock assemblies shall be keyed alike. One (1) key shall be provided with each lock. A clear plastic directory cardholder shall be mounted on the inside of door.
   c. Type 3R, 5, and 12 where indicated.
      1) Enclosures shall be constructed in accordance with UL 50 requirements. Enclosures shall be painted with ANSI 49 gray enamel electrodeposited over cleaned phosphatized steel.
      2) All doors shall be gasketed and equipped with a tumbler type vault lock and two (2) additional quarter turn fasteners on enclosures 59 inches or more in height. All lock assemblies shall be keyed alike. One (1) key shall be provided with each lock. A clear plastic directory cardholder shall be mounted on the inside of door.
      3) Maximum enclosure dimensions shall not exceed 21” wide and 6.5” deep.
5. SURGE PROTECTOR: Innovative Technology PTE-080 or equal by Total Protection Solutions LP Series. Provide 30Amp – 3pole circuit breaker connected to approved supplier surge protector. Maximum lead length is 8 inches. Breaker size per manufacturer.

B. Excepton: Panel 10S1: Provide 200% rated neutral, copper bus, and copper ground and isolated ground bar.

2.4 DISTRIBUTION PANELBOARDS

A. I-LINE Circuit Breaker Distribution Panelboard

1. Interior
   a. Shall be Square D I-LINE type rated 600 Vac or 250 Vdc maximum. Continuous main current ratings as indicated on associated drawings not to exceed 1200 amperes maximum. Where distribution board noted abovge 1200 amperes provide switchboard. Panelboard bus current ratings shall be determined by heat-rise tests conducted in accordance with UL 67.
   b. Provide UL Listed short circuit current ratings (SCCR) as indicated on the associated drawings not to exceed the lowest interrupting capacity rating of any circuit breaker installed with a maximum of 200,000 RMS symmetrical amperes. Main lug and main breaker panelboards shall be suitable for use as Service Equipment when application requirements comply with UL 67 and NEC Articles 230.VI and VII.
   c. The panelboard interior shall have three flat bus bars stacked and aligned vertically with glass reinforced polyester insulators laminated between phases. The molded polyester insulators shall support and provide phase isolation to the entire length of bus.
   d. The bussing shall be fully rated with sequentially phased branch distribution. Panelboard bussing rated 100 through 600 amperes shall be plated copper or aluminum. Bussing rated 800 amperes and above shall be plated copper. Bus bar plating shall run the entire length of the bus bar. The entire interleaved assembly shall be contained between two (2) U-shaped steel channels, permanently secured to a galvanized steel-mounting pan by fasteners.
   e. Interior trim shall be of dead-front construction to shield user from all energized parts. Main circuit breakers through 800 amperes shall be vertically mounted. Main circuit breaker and main lug interiors shall be field convertible for top or bottom incoming feed.
   f. A solidly bonded copper equipment ground bar shall be provided. An additional copper isolated/insulated ground bar shall also be provided.
   g. Solid neutral shall be equipped with a full capacity bonding strap for service entrance applications. Where indicated UL Listed panelboards with 200% rated solid neutrals shall have plated copper neutral bus for non-linear load applications. Gutter-mounted neutral will not be acceptable.
   h. Nameplates shall contain system information and catalog number or factory order number. Interior wiring diagram, neutral wiring diagram, UL Listed label, and Short Circuit Current Rating shall be displayed on the interior or in a booklet format. Leveling provisions shall be provided for flush mounted applications.
2. Group mounted circuit breakers through 1200A
   a. Circuit breaker(s) shall be group mounted plug-on with mechanical restraint on a common pan or rail assembly.
   b. The interior shall have three flat bus bars stacked and aligned vertically with glass reinforced polyester insulators laminated between phases. The molded polyester insulators shall support and provide phase isolation to the entire length of bus.
   c. Circuit breakers equipped with line terminal jaws shall not require additional external mounting hardware. Circuit breakers shall be held in mounted position by a self-contained bracket secured to the mounting pan by fasteners. Circuit breakers of different frame sizes shall be capable of being mounted across from each other.
   d. Line-side circuit breaker connections are to be jaw type.
   e. All unused spaces provided, unless otherwise specified, shall be fully equipped for future devices, including all appropriate connectors and mounting hardware.
3. Thermal magnetic molded case circuit breaker
   a. Molded case circuit breakers shall have integral thermal and instantaneous magnetic trip in each pole.

b. Circuit protective devices shall be Square D molded case circuit breakers. Circuit breakers shall be rated as shown on schedules. Ampere ratings shall be as shown on the drawings.

4. Enclosures
   a. Type 1 Boxes
      1) Boxes shall be galvanized steel constructed in accordance with UL 50 requirements. Zinc-coated galvannealed steel will not be acceptable.
      2) Boxes shall have removable blank end walls and interior mounting studs. Interior support bracket shall be provided for ease of interior installation.
      3) Maximum enclosure dimensions shall be 44” wide and 9.5” deep.
   b. Type 1 Trim Fronts
      1) Trim front steel shall meet strength and rigidity requirements per UL 50 standards. Shall have an ANSI 49 medium gray enamel electrodeposited over cleaned phosphatized steel.
      2) Trim front shall be door in door style hinged 1-piece with door available in flush or surface mount as indicated. Trim front door shall have rounded corners and edges free of burrs. A clear plastic directory cardholder shall be mounted on the inside of the door.
      3) Locks shall be cylindrical tumbler type with larger enclosures requiring sliding vault locks with 3-point latching. All lock assemblies shall be keyed alike. One (1) key shall be provided with each lock.
   c. Type 3R, 5, and 12 where indicated.
      1) Enclosures shall be constructed in accordance with UL 50 requirements. Enclosures shall be painted with ANSI 49 gray enamel electrodeposited over cleaned phosphatized steel.
      2) All doors shall be gasketed and be equipped with a tumbler type vault lock and two (2) additional quarter turn fasteners. A clear plastic directory cardholder shall be mounted on the inside of door. All lock assemblies shall be keyed alike. One (1) key shall be provided with each lock.
      3) Maximum enclosure dimensions shall not exceed 44” wide and 14.5” deep.

B. Housekeeping Pad: When floor mounted proved 3-inch housekeeping pad minimum 3-inches beyond footprint.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install panelboards in accordance with manufacturer's written instructions, NEMA PB 1.1 and NEC standards.

3.2 FIELD QUALITY CONTROL

A. Inspect complete installation for physical damage, proper alignment, anchorage, and grounding.

B. Measure steady state load currents at each panelboard feeder; rearrange circuits in the panelboard to balance the phase loads within 20% of each other. Maintain proper phasing for multi-wire branch circuits.

C. Check tightness of bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written specifications.

END OF SECTION 262416

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. Specification-grade receptacles
2. GFCI receptacles, 125 V, 20 A.
3. Controlled Receptacles
4. Twist-locking receptacles.

1.3 DEFINITIONS

A. GFCI: Ground-fault circuit interrupter.

B. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

1.4 SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

1.7 EXTRA MATERIALS

A. Furnish extra materials described in subparagraphs below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Provide five (5) duplex receptacles and two (2) GFCI receptacles each with fifty feet 3/4-inch EMT-5#12 and four (4) elbows each. All installed at location directed by owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
   1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
   2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
   3. Leviton Mfg. Company Inc. (Leviton).
   4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.2 GENERAL WIRING-DEVICE REQUIREMENTS

A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

B. Comply with NFPA 70.

C. RoHS compliant.

D. Comply with NEMA WD 1.

E. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:
   1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
   2. Devices shall comply with requirements in this Section.

F. Devices for Owner-Furnished Equipment:
   1. Receptacles: Match plug configurations.
   2. Cord and Plug Sets: Match equipment requirements.

G. Device Color:
   1. Wiring Devices Connected to Normal Power System: White unless otherwise indicated or required by NFPA 70 or device listing.
   2. Controlled receptacles: Green

H. Wall Plate Color: Stainless Steel 302.

I. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

J. Plug Tail devices are acceptable.

2.3 STANDARD-GRADE RECEPTACLES, 125 V, 20 A

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

1. Description: Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle. Square face Configuration: NEMA WD 6, Configuration 5-20R.
2. Standards: Comply with UL 498.

B. Products: Subject to compliance with requirements, provide one of the following:

1. Hubbell; HBL5362 (duplex).
2. Leviton; 5362SG (duplex).
3. Pass & Seymour; 5362 (duplex).

C. Controlled receptacles same as A above but green color with “controlled” label and symbol on them. Pass and Seymour# T362CDG

D. Twistlock, to match above, Configuration: NEMA WD 6, Configuration L5-20R. Standards: Comply with UL 498.

E. Isolated-Ground, Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Pass & Seymour; IG5362.

2. Description: Straight blade; equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

2.4 GFCI RECEPTACLES, 125 V, 20 A

A. Duplex GFCI Receptacles, 125 V, 20 A
1. Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle.
2. Configuration: NEMA WD 6, Configuration 5-20R.
3. Standards: Comply with UL 498, UL 943 Class A, and FS W-C-596.
4. No feed through permitted. All to be individual GFI
a. Legrand 2097

2.5 SPECIAL RECEPTACLES

A. Special Receptacles as noted.

2.6 SWITCHES

A. Comply with NEMA WD 1 and UL 20.

B. Switches, 120/277 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Cooper; 2221 (single pole), 2222 (two pole), 2223 (three way), 2224 (four way).
   b. Hubbell; CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224 (four way).
   c. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).
   d. Legrand; 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way).

C. Pilot Light Switches, 20 A:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Cooper; 2221PL for 120 V and 277 V.
      b. Hubbell; HPL1221PL for 120 V and 277 V.
      c. Leviton; 1221-PLR for 120 V, 1221-7PLR for 277 V.
      d. Legrand; PS20AC1-PLR for 120 V.

   2. Description: Single pole, with neon-lighted handle, illuminated when switch is "ON."

2.7 OCCUPANCY SENSORS, DIMMERS – SEE 260923

2.8 WALL PLATES

A. Single Source: Obtain wall plates from same manufacturer of wiring devices.

B. Single and combination types shall match corresponding wiring devices.
   1. Plate-Securing Screws: Metal with head color to match plate finish.
   2. Material for Finished Spaces: 0.035-inch- (1-mm-) thick, satin-finished, Type 302 stainless steel
   3. Material for Unfinished Spaces: Galvanized steel. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.

C. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant, die-cast aluminum while in use with lockable cover.

D. Emergency receptacles and switches shall receive stainless steel plate with red engraved emergency on cover.

2.9 FLOORBOXES

A. Type: Modular, flush-type, 8 mounting positions suitable for wiring method used with flush cover.

B. Compartments: Barrier separates power from voice and data communication cabling.

C. Power Receptacle: NEMA WD 6 configuration 5-20R, isolated, as indicated on drawings.

D. Voice and Data Communication Outlet Bracket: Custom to match outlet.

E. Hubbell CFB501Base with HBLTCGNT scrubproof cover or Wiremold Evolution 6. When installed in concrete slab provide Hubbell AFB501BASE insert with Cast Iron Pour Box (HBL501PB).

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.

B. Coordination with Other Trades:
1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes, and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:
1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall comply with NFPA 70, Article 300, without pigtails.
4. Existing Conductors:
   a. Cut back and pigtail, or replace all damaged conductors.
   b. Straighten conductors that remain and remove corrosion and foreign matter.
   c. Pigtailing existing conductors is permitted, provided the outlet box is large enough.

D. Device Installation:
1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches (152 mm) in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:
1. Install ground pin of vertically mounted receptacles up], and on horizontally mounted receptacles to the right.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

H. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 IDENTIFICATION

A. Comply with Section 260553 "Identification for Electrical Systems."

B. Identify each receptacle with panelboard identification and circuit number in box.
   1. Exception: Label each receptacle plate in shop, electrical and mecahnical rooms. Use hot, stamped, or engraved machine printing with black or red(emergency)-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.3 FIELD QUALITY CONTROL

A. Test Instrument for Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

B. Tests for Receptacles:
   1. Line Voltage: Acceptable range is 105 to 132 V.
   2. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
   3. Using the test plug, verify that the device and its outlet box are securely mounted.
   4. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault-current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

C. Wiring device will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 262726

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Fusible switches.
   2. Nonfusible switches.
   3. Molded-case circuit breakers (MCCBs).
   4. Molded-case switches.
   5. Enclosures.

B. See section 260573 for protective device coordination study requirements. All equipment specified herein shall comply with the requirements of 260573. All equipment shall be increased in size, electronic trip added, wire and conduit size increased as require to provide a complete selectively coordinated system. Nothing in the following specification relieves the contractor from providing a complete selectively coordinated system. Fuses shall not be used to provide selective coordination.

1.2 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

C. SPDT: Single pole, double throw.

1.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. The term "withstand" means “the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified.”

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.
   1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Comply with NFPA 70.

1.5 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.6 SPARE FUSE CABINET

A. Provide spare fuse cabinet to house all fuses uysed on the project. Mount one in each building main electric room.

1.7 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
   2. Fuse Pullers: Two for each size and type.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

A. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

B. Type HD, Heavy Duty, Six Pole, Single Throw, 600-V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Type HD, Heavy Duty, Double Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

D. Accessories:
   1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
   2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
   3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.

4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
5. Auxiliary Contact Kit: NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open where required.
6. Hookstick Handle: Allows use of a hookstick to operate the handle.

7. Service-Rated Switches: Labeled for use as service equipment.

E. Fuses: Class RK1, Time Delay. Bussman low-peak

2.2 NONFUSIBLE SWITCHES

A. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

B. Type HD, Heavy Duty, Six Pole, Single Throw, 600-V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Type HD, Heavy Duty, Double Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

D. Accessories:
1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
4. Auxiliary Contact Kit: NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open where required.
5. Hookstick Handle: Allows use of a hookstick to operate the handle.

2.3 MOLDED-CASE CIRCUIT BREAKERS

A. Manufacturers: Subject to compliance with requirements, provide products to match panelboard breakers.

B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.

C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

D. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).

E. Ground-Fault, Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).

2.4 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
   1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
   2. Outdoor Locations: NEMA 250, Type 3R.
   3. Shop Areas: NEMA 250, Type 4X, stainless steel.
   4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
   5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

B. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Install fuses in fusible devices.

E. Comply with NECA 1.

END OF SECTION 262816

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes ac, enclosed controllers rated 600 V and less, of the following types:
   1. Across-the-line, manual and magnetic controllers.

1.2 SUBMITTALS

A. Product Data: For each type of enclosed controller. Include dimensions and manufacturer's technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each enclosed controller.
   1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
      a. Each installed unit's type and details.
      b. Nameplate legends.
      c. Short-circuit current rating of integrated unit.
      d. Listed and labeled for series rating of overcurrent protective devices in combination controllers by an NRTL acceptable to authorities having jurisdiction.
      e. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices in combination controllers.
   2. Wiring Diagrams: Power, signal, and control wiring.

1.3 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 100 miles (160 km) of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed controllers, minimum clearances between enclosed controllers, and for adjacent surfaces and other items. Comply with indicated maximum dimensions and clearances.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

B. If stored in areas subject to weather, cover enclosed controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install electric heating of sufficient wattage to prevent condensation.

1.5 COORDINATION

A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

C. Coordinate features of enclosed controllers and accessory devices with pilot devices and control circuits to which they connect.

D. Coordinate features, accessories, and functions of each enclosed controller with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

1.6 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Spare Fuses: Furnish one spare for every five installed, but no fewer than one set of three of each type and rating.
   2. Indicating Lights: Two of each type installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. ABB Power Distribution, Inc.; ABB Control, Inc. Subsidiary.
   2. Danfoss Inc.; Danfoss Electronic Drives Div.
   3. Eaton Corporation; Cutler-Hammer Products.
   4. General Electrical Company; GE Industrial Systems.
   5. Rockwell Automation; Allen-Bradley Co.; Industrial Control Group.
   6. Siemens/Furnas Controls.
   7. Square D.

2.2 ACROSS-THE-LINE ENCLOSED CONTROLLERS

A. Manual Controller (Starter): NEMA ICS 2, general purpose, Class A, with "quick-make, quick-break" toggle or pushbutton action, and marked to show whether unit is "OFF," "ON," or "TRIPPED."
   1. Overload Relay: Ambient-compensated type with inverse-time-current characteristics and NEMA ICS 2, Class 10 tripping characteristics. Relays shall have heaters and sensors in each phase, matched to nameplate, full-load current of specific motor to which they connect and shall have appropriate adjustment for duty cycle.

B. Magnetic Controller (Starter): NEMA ICS 2, Class A, full voltage, nonreversing, across the line, unless otherwise indicated.
   1. Control Circuit: 120 V; obtained from integral control power transformer with a control power transformer of sufficient capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity.
   2. Overload Relay: Ambient-compensated type with inverse-time-current characteristic and NEMA ICS 2, Class [10] tripping characteristic. Provide with heaters or sensors in each phase matched to nameplate full-load current of specific motor to which they connect and with appropriate adjustment for duty cycle.
   3. Hand off auto switch.
   4. Red running and green stop pilot lights.
   5. Control transformer.

C. Combination Magnetic Controller (Starter): Factory-assembled combination controller and disconnect switch.
   1. Fusible Disconnecting Means: NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 947-4-1, as certified by an NRTL.
   2. Magnetic controller per above.
   3. Fuses: Class RK1, Time Delay

2.3 MULTISPEED ENCLOSED CONTROLLERS

A. Multispeed Enclosed Controller: Match controller to motor type, application, and number of speeds; include the following accessories:
   1. Compelling relay to ensure that motor will start only at low speed.
   2. Accelerating relay to ensure properly timed acceleration through speeds lower than that selected.
   3. Decelerating relay to ensure automatically timed deceleration through each speed.

2.4 ENCLOSURES

A. Description: Flush- or surface-mounting cabinets as indicated. NEMA 250, Type 1, unless otherwise indicated to comply with environmental conditions at installed location.
   1. Outdoor Locations: NEMA 250, Type 4.
   2. Kitchen and Shop Areas: NEMA 250, Type 4X, stainless steel.
   3. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
   4. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.

2.5 ACCESSORIES

A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.

B. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.

C. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

D. Control Relays: Auxiliary and adjustable time-delay relays.

E. Phase-Failure and Undervoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connection. Provide adjustable undervoltage setting. Phase failure relays are only required on motors 7.5 HP and larger.

2.6 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested enclosed controllers before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and surfaces to receive enclosed controllers for compliance with requirements, installation tolerances, and other conditions affecting performance.
1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Select features of each enclosed controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, controller, and load; and configuration of pilot device and control circuit affecting controller functions.

B. Select horsepower rating of controllers to suit motor controlled.

3.3 INSTALLATION

A. For control equipment at walls, bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Division 26 Section "Hangers, Supports and Fasteners."

B. Enclosed Controller Fuses: Install fuses in each fusible switch.

3.4 IDENTIFICATION

A. Identify enclosed controller, components, and control wiring according to Division 26 Section "Identification for Electrical Systems."

3.5 CONTROL WIRING INSTALLATION

A. Install wiring between enclosed controllers.

B. Bundle, train, and support wiring in enclosures.

C. Connect hand-off-automatic switch and other automatic-control devices where applicable.
   1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.
   2. Connect selector switches with enclosed controller circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.6 CONNECTIONS

A. Conduit installation requirements are specified in other Division 26 Sections. Drawings indicate general arrangement of conduit, fittings, and specialties.

B. Ground equipment according to Division 26 Section "Grounding."

3.7 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:
   1. Test insulation resistance for each enclosed controller element, bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

B. Perform the following field tests and inspections and prepare test reports:
   1. Perform each electrical test and visual and mechanical inspection, except optional tests, stated in NETA ATS, "Motor Control - Motor Starters." Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.8 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 262913

PART 1 - GENERAL

1.1 WORK INCLUDES

A. In base bid add manual transfer switch and Camloc and equivalent to UL2200 field listing to existing 35 KW generator.
   1. In alternate bid “A” provide a new 125 KW diesel generator.
   2. In alternate bid “B” provide 125 KW natural gas generator with automatic changeover to Propane same as existing

1.2 See section 260573 for protective device coordination study requirements. All equipment specified herein shall comply with the requirements of 260573. All equipment shall be increased in size, electronic trip added, wire and conduit size increased as require to provide a complete selectively coordinated system. Nothing in the following specification relieves the contractor from providing a complete selectively coordinated system. Fuses shall not be used to provide selective coordination. The coordination study (260573) shall be completed and stamped by the coordination engineering and all changes incorporated into the panel and gear prior to submitting for approval. All equipment shall take into account all requirements of the coordination study.

1.3 REFERENCES

A. NFPA 70 - National Electrical Code.

B. NEMA ICS 1 - General Standards for Industrial Control and Systems.

C. NEMA ICS 2 - Standards for Industrial Control Devices, Controllers, and Assemblies.

D. NEMA ICS 6 - Enclosure for Industrial Controls and Systems.

1.4 SUBMITTALS

A. Product Data: Provide catalog sheets showing, spark-ignited generator set, voltage, switch size, ratings and size of switching and overcurrent protective devices, operating logic, short circuit ratings, dimensions, and enclosure details.

B. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

1.5 OPERATION AND MAINTENANCE DATA

A. Operation Data: Include instructions for operating equipment. Include instructions for operating equipment under emergency conditions when engine generator is running.

B. Maintenance Data: Include routine preventive maintenance and lubrication schedule. List special tools, maintenance materials, and replacement parts.

PART 2 - PRODUCTS

2.1 EMERGENCY STANDBY POWER SYSTEM

A. Manufacturer: Cummins or equal by MPU or Kohler. The manufacturer of the emergency generator system shall be represented by a service organization which is capable of assisting in coordination of all components including generator unit, fuel system, engine exhaust system, power wiring and control wiring to insure a complete workable system suitable for emergency standby service. The manufacturer's service organization shall also be capable of completely testing generator system, of servicing and maintaining the equipment after installation on a 24 hour a day basis. Emergency generator system must be a standard package unit of the manufacturer; a build-up unit will not be acceptable. All catalog numbers refer to Cummins.

B. Other alternate equipment manufacturers not listed shall be considered by the Contractor only when specifically identified by Addendum to the plans and specifications. Other manufacturers which desire to be designated as acceptable shall deliver a detailed statement of qualifications to the Engineer at least twenty-one (21) calendar days prior to the scheduled bid opening. The statement of qualifications include pertinent items listed below:
   1. Description of company.
   2. Resumes of principals and/or key employees.
   3. Description of expertise in design, assembly, and installation of diesel engine-driven generator sets.
   4. Description of generator sets designed, assembled and installed in the last ten (10) years. Description shall include:
      a. Names of employees involved in each system.
      b. Detailed description and drawings of each system.
      c. Cost of each system.
      d. Names and telephone numbers of persons involved in operation and maintenance of each system.

C. Description of the service capabilities normally provided by the company including resumes of employees assigned to field service and listing of service equipment.

D. Detailed plan and elevation drawings of the proposed generator set indicating overall dimensions and the specific location of all components, including the engine exhaust system.

E. Detailed specifications and standard operating characteristics of the engine, the generator and all components.

F. Additional information that may assist the Engineer in evaluation of the manufacturer and/or proposed generator set.

G. Acceptability of the manufacturers will be determined by the Owner and the acceptable manufacturers will be designated by Addendum mailed to holders of plans and specifications at least ten (10) working days prior to the date of opening of bids.

2.2 CAPACITY AND TYPE

A. The generator unit shall be Cummins KW rating on drawings electric generating set rated for continuous standby service at KVA rating shown on drawings, 480Y/277 volt, 3-phase, 4-wire, 60 Hertz (minimum). Generator shall be 12 lead to able to capable to be switched to 208Y/120 volt operation. The system of package of new and current equipment consisting of:
1. Natural gas engine driven electric generator set to provide standby power.
2. An engine start-stop control system mounted on the generating set.
3. An automatic load transfer control to provide automatic starting and stopping of the engine and switching of the load.
4. Mounted accessories as specified.

B. This system shall be built, tested and shopped by the manufacturer of the alternator so there is one source of supply and responsibility. The performance of this generating set series shall be certified by an independent testing laboratory as to the set's full power rating, stability and voltage and frequency regulation. This standby electric power system, furnished completely by the manufacturer, shall be warranted for a period of five years from the date of installation. Five year warranty shall provide a full comprehensive parts, labor and travel time warranty with no deductibles. Certificates shall be provided to owner after startup and acceptance.

C. Engine: The engine shall be natural gas fueled, 4-cycle, water cooled with mounted radiator, fan and pump. Operating speed shall be 1800 rpm. Overhead valve design. Hard faced exhaust valves with rotators shall be provided. Lubrication shall be full pressure as supplied by a positive displacement lube oil pump. The engine shall have an air cleaner and oil filter with replaceable elements, and mounted secondary fuel flow regulator. Engine speed shall be governed by a electronic governor to maintain alternator output. The engine shall have a 12 volt battery charging DC alternator with transistorized voltage regulator. Remote starting shall be by a 12 volt, solenoid shift, electric starter.

2.3 ALTERNATOR

A. Type: Revolving field, 4 pole brushless, broad range, twelve lead reconnectable alternator.

B. Construction: Laminations and winding designed for minimum reactance, low voltage wave form distortion and maximum efficiency. Amortisseur windings for improved AC wave form and reduced field heating and acting as a stabilizer for paralleling. A skewed stator to minimize noise and voltage harmonics.

C. Exciter: Rotating brushless exciter and rectifiers. Silicon controlled rectifiers to have phase controlled sensing current.

D. Temperature Rise: Temperature rise at rated load shall be within NEMA #MG-1-22-40 definition and shall not exceed 105 degrees Celsius over 40 degrees Celsius.

E. Insulating System: Class H as defined by NEMA MG1-1.65 and insulation varnish to conform to MIL 1-24092.

F. Frequency Regulation: Three cycles maximum no load to continuous rated load

G. Voltage Regulator: Solid state type with "automatic voltage reduction" feature. If load demand exceeds engine capability to prevent stalling of engine due to momentary overload.

H. Voltage Regulation: Plus or minus 2% from no load to continuous rated load.

I. Voltage Adjustment: A rheostat shall provide plus or minus 5% voltage adjustment.

J. Voltage Wave Form: Voltage wave form deviation factor shall be less than NEMA MG1-22.43 definition.

K. Steady State Operation: Frequency variation shall not exceed plus or minus 0.5% (plus or minus 0.3 Hertz) and voltage band width plus or minus 1% of their mean value for constant load from no load to continuous rated load.

L. Radio Interference Suppression: Shall be in accordance with standard of commercial application.

2.4 CONTROLS

A. All engine controls, signal lights, gauges, and generator instruments shall be incorporated in a single NEMA 1 enclosure for simplicity and convenience of operating personnel. It shall be shock mounted over the alternator. Control and monitor devices shall meet or exceed requirement of NFPA 99.

B. Engine Controls
1. Oil pressure gauge
2. Water temperature gauge
3. Battery charge rate ammeter
4. 3 position selector switch (Run, Off, Remote)
5. Low engine temperature alarm contacts and indicator light
6. High water temperature cutoff
7. Low oil pressure cutoff
8. Overspeed shutdown - shall be mechanical device separated and apart from engine speed control governor.
9. Overcranking protection (after a cranking cycle of three 15 second attempts with 15 second rests, one minute cranking shall discontinue, as per NFPA 110).
10. Individual alarm contacts and individual fault lights to operate in the event of engine shutdown by 6, 7, 8, or 9 above.
11. Indicator panel light.

C. Alternator Controls/Instrument Panel
1. Manual reset circuit breaker (Field breaker)
2. Voltmeter (dual range - internally connected for all output voltage connections)
3. Voltage adjusting rheostat (+5%)
4. Frequency meter
5. Running time meter
6. Ammeter (dual range)
7. Meter switch
8. Main output load breaker

2.5 FUEL SYSTEM

A. Primary fuel system shall be natural gas. The following accessory items shall be provided and connected:

B. Liquid fuel filter/lock off valve

C. 12-volt fuel solenoid valve
1. Flexible fuel line section, approved for LPG liquid
~~2.~~ Natural gas fuel solenoid and pressure sensor

2.6 COOLING

A. The engine shall be radiator and fan cooled.

2.7 ENGINE GENERATOR ENCLOSURE

A. Description: Sound Attenuated Steel housing. Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Instruments, control, and battery system shall be mounted within enclosure.

B. Construction:
1. Hinged Doors: With padlocking provisions. Restraint/Hold back hardware to prevent door to keep door open at 180 degrees during maintenance. Rain lips over all doors.
2. Exhaust System: Muffler Location: Within enclosure.
3. Hardware: All hardware and hinges shall be stainless steel.
4. Mounting Base: Suitable for mounting on sub-base fuel tank or housekeeping pad.
5. A weather protective enclosure shall be provided which allows the generator set to operate at full rated load with a static pressure drop equal to or less than 0.5 inches of water.
6. Engine Cooling Airflow through Enclosure: Housing shall provide ample airflow for engine generator operation at rated load in an ambient temperature of 40 deg C.
7. Sound Performance: Reduce the sound level of the engine generator while operating at full rated load to a maximum of 73 dBA measured at any location 7 m from the engine generator in a free field environment.

2.8 ADDITIONAL EQUIPMENT AND ACCESSORIES

A. Starting batteries shall be lead acid type. Batteries shall be 12 volt and shall include electrolyte battery cables, a steel battery rack and hydrometer.

B. Solid state cycle cranking, adjustable type with durations of 15 seconds crank and 15 ~~10~~ seconds rest. Termination of the crank-rest cycles will be after 3 attempts or in 75 seconds and overdrank safety will then open start circuit.

C. Provide critical rated silencer, mounted inside eng/generator enclosure with rain cap or mounted integral to generator housing. Direct exhaust vertically with raincap.

D. Seamless stainless steel flex shall be connected between engine and muffler.

E. Mounted prewired line circuit breaker rated in generator as shown on drawings.

F. Water jacket engine heater thermostatically controlled to operate within range of 120 degrees to 130 degrees F, 120 volts, 2000 watts.

G. Provide remote annunciator panel located as shown on drawings and shall meet requirement of NFPA 99 Onan ANN series or equal.

H. Three copies of detailed operation and maintenance manuals with parts list.

I. Interconnecting and wiring diagrams, specification sheets, and outline drawings of exact equipment being supplied are to be furnished with submittals.

J. Copy of manufacturers' warranty shall be included with submittals.

K. Provide factory certified test reports to owner and engineer showing maximum power capability of generator set supplied, voltage regulation and frequency regulation.

2.9 LOAD TRANSFER CONTROL

A. Automatic system load transfer control Onan model OTEC series shall be furnished rated 42,000 AIC (minimum). The automatic load transfer control shall be provided with four poles for a normal service to match the output of the generator set. Adjustable close differential relays shall be provided to transfer the load circuits to the emergency source when any phase drops below 83% normal voltage and automatically retransfer when all phases are 90% or more of normal voltage.

B. All accessories and features listed as standard on Onan OTEC series transfer switch shall be included plus accessories as specified.

C. The transfer switch shall be mechanically and electrically held and rated to 600 volts for all classes of load and continuous inductive duty.

D. High Current Breaking Capacity

E. Capable of switching loads up to 15 time the continuous rating of the switch at rated voltage.

F. Endurance: Must be capable of enduring 6000 cycles of operation complete opening and closing of the contact at rated current and voltage at a rate of 6 cycles per minute without failure.

G. Also must be capable of a continuous 10% overload (1.10 service factor) on the nameplate ampere rating without exceeding safe operating temperature.

H. The switch shall be double throw inherently interlocked mechanically and electrically to prevent supplying the load from both sources simultaneously. The operating current shall be obtained from the source tow high the load is to be transferred. The transfer mechanism shall be of the double break design with solid silver cadmium surface contacts and individual heat resistant arching chamber.

I. Arc barriers and magnetic blow out coils will also be acceptable, if single break contacts are used. Failure of any coil or disarrangement of any part shall not permit a neutral position. The

contacts must be capable of carrying 20 times the continuous rating of the switch without welding and 15 times the continuous rating for interrupting current.

J. All contacts, coils, etc., shall be readily accessible for emplacement from front of panel without major disassembly of associated parts.

K. The transfer switch shall have Underwriters Laboratory listing. The transfer switch shall be mounted in a NEMA 1 cabinet.

2.10 MANUAL TRANSFER SWITCH

A. Quality Assurance
1. Manual transfer switch shall be UL listed and labeled under the UL 1008 standard.
2. Manual transfer switch shall be special seismic certified by OSHPD exclusively on the basis of approved shake table testing, and also certified to IBC 2015. Minimum IBC 2015 design parameters shall be as follows: Ip = 1.5, SDS = 2.0g, z/h = 1.0
3. Manual transfer switch manufacturer shall provide a complete factory assembled, wired and tested manual transfer switch.
4. Manual transfer switch shall be factory Hi-pot tested for a period of not less than 60 seconds.
5. Manual transfer switch installation shall meet all applicable NEC standards
6. Manual Transfer Switch shall be 480 volt rated and 3 pole

B. Manual Transfer Switch
1. Shall be ESL Power Systems StormSwitch Series 3020 or alternate accepted equal.
2. Manual transfer switch shall consist of (2) two mechanically-interlocked molded case circuit breakers, cam-style male connectors, power distribution block and grounding terminals, all housed within a padlockable enclosure.
3. Manual transfer switch enclosure shall be Type 3R, constructed of continuous seam-welded, powder coated galvanneal steel. The main access shall be through an interlocked, hinged door that extends the full height of the enclosure. Access for portable generator cables with female cam-style plugs shall be via a) drawn flange cable entry openings in the bottom of enclosure for wall mount units, or b) hinged lower door for pad mount units. A hinged flap door shall be provided to cover the cable openings when cables are not connected; the hinged flap door shall allow cable entry only after the main access door has been opened. Enclosure shall be powder coated after fabrication; color shall be wrinkle gray RAL 7035.
4. Cam-style male connectors (inlets) shall be UL Listed single-pole separable type and rated 400 amps at 600VAC. Cam-style male connectors shall be color coded. Cam-style male connectors shall be provided for each phase and for ground, and shall also be provided for neutral if required. Each of the phase cam-style male connectors within the enclosure shall be factory-wired to a molded case circuit breaker. The ground cam-style male connectors shall be bonded to the enclosure, and a ground lug shall be provided for connection of the facility ground conductor. The neutral cam-style male connectors, if required, shall be factory wired to a power distribution block. None of the cam-style male connectors shall be accessible unless both molded case circuit breakers are in the “OFF” position and the main access door is open.
5. A power distribution block shall be provided for load-side field wiring. The power distribution block shall be factory wired to the molded case circuit breakers.
6. Molded case circuit breakers shall be UL Listed and the short circuit interrupt rating shall be a minimum of 35kAIC at 480VAC. Trip rating of the molded case circuit breakers shall be as shown on the drawings. One molded case circuit breaker shall be fed from utility

power; the other molded case circuit breaker shall be fed from the cam-style male connectors to supply power from a portable generator. Both molded case circuit breakers shall include UL Listed door-mounted operating mechanisms, preventing the opening of the main access door unless both breakers are in the “OFF” position. Both molded case circuit breakers shall be mounted behind a deadfront panel. The load-side of the molded case circuit breakers shall not be energizable unless the main access door is closed and one of the molded case circuit breakers is in the “ON” position. The (2) molded case circuit breakers shall be safety interlocked by mechanical means to ensure that only one breaker can be closed at any given time.

7. Manual transfer switch shall be suitable for use as service equipment in the USA as defined by the NEC.

2.11 CONCRETE PAD

A. Provide concrete pad under generator, extending minimum 6 inches beyond footprint.

2.12 ACCESSORIES

A. Adjustable solid state low voltage sensing relays (start 5% to 20% below stop setting; stop 75% to 100%) - (3 phase sensing).

B. Adjustable time delay on start (0 to 15 seconds)

C. Adjustable time delay on retransfer to normal (0 to 30 minutes)

D. Automatic battery float charger, automatic charge rate 0 to 2 amps with charge rate meter.

E. Power failure simulated test switch. Test transfer switch permits plant to take over load when plant is being checked.

F. Clock Exerciser - automatically start and run plant under loaded emergency condition.

G. Adjustable delay neutral - 0 to 7.5 seconds.

H. Operation Selector Switch - 3 position, check, automatic, stop.

I. Adjustable time delay transfer to emergency. (0 to 120 seconds).

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install per manufacturer's requirements.

3.2 FIELD TEST AND DEMONSTRATION

A. The emergency power system shall be tested after installation by representative of the manufacturer in the presence of the engineer. All functions of the emergency power system shall be tested to the engineer's satisfaction. The system shall be tested under simulated power failure conditions and operated under emergency conditions minimum period of one hour. Provide auxiliary load banks to provide full load testing.

B. Include 8 hours of training of Owner’s personnel. All training shall be video taped by installer and 3 copies of tape provided to Owner.

END OF SECTION 263323

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Solid-state luminaires that use LED technology.
   2. Lighting fixture supports.

B. Related Requirements:
   1. Section 260923 " for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
   2. Section 260936 for architectural dimming systems and for fluorescent dimming controls with dimming ballasts specified in interior lighting Sections.
   3. Section 260943 for manual or programmable control systems with low-voltage control wiring or data communication circuits.

1.2 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color Rendering Index.

C. Fixture: See "Luminaire."

D. IP: International Protection or Ingress Protection Rating.

E. LED: Light-emitting diode.

F. Lumen: Measured output of lamp and luminaire, or both.

G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Arrange in order of luminaire designation.
   2. Include data on features, accessories, and finishes.
   3. Include physical description and dimensions of luminaires.
   4. Include emergency lighting units, including batteries and chargers.
   5. Include life, output (lumens, CCT, and CRI), and energy efficiency data.
   6. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing and Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps and accessories identical to those indicated for the lighting fixture as applied in this Project, IES LM-79 and IES LM-80.
      a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.

B. Shop Drawings: For nonstandard or custom luminaires.
1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

C. Fixture requirements:
1. DLC – all fixtures shall have DLC or Energy Star label
a. Fixtures specified that do not have DLC label are exempt

D. Retain "Samples" Paragraph for custom luminaires and single-stage samples. Retain "Samples for Initial Selection" and "Samples for Verification" paragraphs for two-stage Samples.

E. Samples: For each luminaire and for each color and texture with standard factory-applied finish where requested.

F. Samples for Initial Selection: For each type of luminaire with custom factory-applied finishes.
1. Include Samples of luminaires and accessories involving color and finish selection.

G. Samples for Verification: For each type of luminaire.
1. Include Samples of luminaires and accessories to verify finish selection.

H. Product Schedule: For luminaires and lamps. See Drawings for schedule

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Lighting luminaires.
2. Suspended ceiling components.
3. Partitions and millwork that penetrate the ceiling or extend to within 12 inches (300 mm) of the plane of the luminaires.
4. Structural members to which luminaires will be attached.
5. Initial access modules for acoustical tile, including size and locations.
6. Items penetrating finished ceiling, including the following:
a. Other luminaires.
b. Air outlets and inlets.
c. Speakers.
d. Sprinklers.
e. Access panels.
f. Ceiling-mounted projectors.
7. Moldings.

B. Qualification Data: For testing laboratory providing photometric data for luminaires.

C. Seismic Qualification Certificates: For luminaires, accessories, and components, from manufacturer.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

D. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Product Certificates: For each type of luminaire.

F. Product Test Reports: For each luminaire, for tests performed by a qualified testing agency.

G. Sample warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.
   1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.6 SPARE MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. LED Drivers/Power Supplies: Provide 1 for each fixture type except:
   2. Provide (4) LED Driver/Power Supplies for RL-1

1.7 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.

B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.

C. Provide luminaires from a single manufacturer for each luminaire type.

D. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

E. Mockups: For interior lighting luminaires in room or module mockups, complete with power and control connections.
   1. Obtain Architect's approval of luminaires in mockups before starting installations.
   2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.

3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.9 TEST REPORTS

A. LED Luminaire IES LM-79: Test Report Submit test report on manufacturer's standard production model luminaire. Include all applicable and required data as outlined under "14.0 Test Report"

B. LED Light Source IES LM-80 Test Report: Submit report on manufacturer's standard production LED light source (package, array, or module). Include all applicable and required data as outlined under

C. LED Light Source IES TM21 Test Report: Submit test report on manufacturer's standard production LED light source (package, array or module). Include all applicable and required data, as well as required interpolation information as outlined in IES TM-21.

1.10 LUMINAIRE USEFUL LIFE CERTIFICATE

A. Submit certification from the manufacturer indicating the expected useful life of the luminaires provided. The useful life must be directly correlated from the IES LM-80 test data using procedures outlined in IES TM-21. Thermal properties of the specific luminaire and local ambient operating temperature and conditions must be taken into consideration

1.11 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

B. Verify available warranties and warranty periods.

C. Warranty Period: Minimum Five year(s) from date of Substantial Completion unless manufacturers standard warranty is longer

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to ASCE/SEI 7

B. Seismic Performance: Luminaires and lamps shall be labeled vibration and shock resistant.
   1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified and the luminaire will be fully operational during and after the seismic event."

2.2 LUMINAIRE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.

C. Recessed Fixtures: Comply with NEMA LE 4.

D. Bulb shape complying with ANSI C79.1.

E. Lamp base complying with ANSI C81.61

F. CRI of minimum 80 unless noted. CCT of 3500 K unless noted

G. Minimum Rated lamp life of 50,000 hours.

H. Lamps dimmable from 100 percent to 0 percent of maximum light output.

I. Internal driver.

J. Nominal Operating Voltage: Per Drawings
   1. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.

K. Housings:
   1. Extruded-aluminum housing and heat sink.
   2. Custom color per architect from provided paint chip

2.3 MATERIALS

A. Metal Parts:
   1. Free of burrs and sharp corners and edges.
   2. Sheet metal components shall be steel unless otherwise indicated.
   3. Form and support to prevent warping and sagging.

B. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to

prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

C. Diffusers and Globes: Per drawings
   1. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
   2. Glass: Annealed crystal glass unless otherwise indicated.
   3. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.

D. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
   1. Label shall include the following lamp characteristics:
      a. "USE ONLY" and include specific lamp type.
      b. Lamp diameter, shape, size, wattage, and coating.
      c. CCT and CRI for all luminaires.

2.4 LED POWER SUPPLIES/DRIVERS

A. UL 8750 LED power supplies (drivers) must be electronic, UL Class 1 , constant-current type and comply with the following requirements:

B. Output power (watts) and ouput current (mA) as shown in luminaire schedule for each luminaire type to meet minimum luminaire efficacy (LE) value provided.

C. Power Factor (PF) greater than or equal to .90.

D. Total Harmonic Distortion (THD) of less than 20%.

E. Class A sound rating.

F. Operable at input voltage of 120-277 volts at 60 hertz.

G. Minimum 5 year manufacturer's warranty.

H. RoHS compliant.

I. Integral thermal protection that reduces output power if case temperature exceeds 185 degrees F 85 degrees C

2.5 METAL FINISHES

A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.6 LUMINAIRE FIXTURE SUPPORT COMPONENTS

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.

C. Wires: ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm)

D. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.

E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before fixture installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting and install new lamps.

3.3 INSTALLATION

A. Comply with NECA 1.

B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

C. Install lamps in each luminaire.

D. Supports:
1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position after cleaning and relamping.
3. Provide support for luminaire without causing deflection of ceiling or wall.
4. Luminaire mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and vertical force of 400 percent of luminaire weight.

E. Flush-Mounted Luminaire Support:
1. Secured to outlet box.
2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
3. Trim ring flush with finished surface.

F. Wall-Mounted Luminaire Support:

1. Attached to structural members in walls or Attached to a minimum 20 gauge backing plate attached to wall structural members
2. Do not attach luminaires directly to gypsum board.

G. Ceiling-Mounted Luminaire Support:
1. Ceiling mount with two 5/32-inch- (4-mm-) diameter aircraft cable supports connected to structur above ceiling
2. Ceiling mount with pendant mount with minimum 5/32-inch- (4-mm-)]diameter aircraft cable supports.
3. Ceiling mount with hook mount.

H. Suspended Luminaire Support:
1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and tubing or rod wire support for suspension for each unit length of luminaire chassis, including one at each end.
4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

I. Ceiling-Grid-Mounted Luminaires:
1. Secure to any required outlet box.
2. Retain first subparagraph below to require ceiling grid to be connected to building structure at four corners of luminaire opening.
3. Secure luminaire to the luminaire opening using approved fasteners in a minimum of four locations, spaced near corners of luminaire.
4. Retain subparagraph below if ceiling grid is not connected to building structure at four corners of the luminaire opening.
5. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

J. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

3.6 STARTUP SERVICE

A. Comply with requirements for startup specified in Section 260943.16 "Addressable-Fixture Lighting Controls."

B. Comply with requirements for startup specified in Section 260943.23 "Relay-Based Lighting Controls."

3.7 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.
   1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
   2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
   3. Adjust the aim of luminaires in the presence of the Architect.

END OF SECTION 265100

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Exterior solid-state luminaires that are designed for and exclusively use LED lamp technology.
   2. Luminaire supports.
   3. Luminaire-mounted photoelectric relays.
   4. Luminaire poles

1.2 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color rendering index.

C. Fixture: See "Luminaire."

D. IP: International Protection or Ingress Protection Rating.

E. Lumen: Measured output of lamp and luminaire, or both.

F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of luminaire.
   1. Arrange in order of luminaire designation.
   2. Include data on features, accessories, and finishes.
   3. Include physical description and dimensions of luminaire.
   4. Lamps, include life, output (lumens, CCT, and CRI), and energy-efficiency data.
   5. Photometric data and adjustment factors based on laboratory tests, complying with IES Lighting Measurements Testing and Calculation Guides, of each luminaire type. The adjustment factors shall be for lamps and accessories identical to those indicated for the luminaire as applied in this Project IES LM-79 and IES LM-80.
      a. Manufacturer's Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the NVLAP for Energy Efficient Lighting Products.
      b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
   6. Wiring diagrams for power, control, and signal wiring.
   7. Photoelectric relays.
   8. Means of attaching luminaires to supports and indication that the attachment is suitable for components involved.

B. Shop Drawings: For nonstandard or custom luminaires.

1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

C. Fixture Ratings
1. Bug Rating
2. USGBC Leed
3. DLC listing
4. Lighting Design Labs

D. Samples: For each luminaire and for each color and texture indicated with factory-applied finish.

E. Product Schedule: For luminaires, poles, and lamps. See Drawings

F. Delegated-Design Submittal: For luminaire supports.
1. Include design calculations for luminaire supports and seismic restraints.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Luminaires.
2. Structural members to which equipment and luminaires will be attached.
3. Underground utilities and structures.
4. Existing underground utilities and structures.
5. Above-grade utilities and structures.
6. Existing above-grade utilities and structures.
7. Building features.
8. Vertical and horizontal information.

B. Qualification Data: For testing laboratory providing photometric data for luminaires.

C. Seismic Qualification Certificates: For luminaires, accessories, and components, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Product Certificates: For each type of the following:
1. Luminaire.
2. Photoelectric relay.

E. Product Test Reports: For each luminaire, for tests performed by a qualified testing agency.

F. Source quality-control reports.

G. Sample warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires [and photoelectric relays] to include in operation and maintenance manuals.
   1. Provide a list of all lamp types used on Project. Use ANSI and manufacturers' codes.
   2. Provide a list of all photoelectric relay types used on Project; use manufacturers' codes.

1.6 SPARE MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. LED Drivers/Power Supplies: One for each type
   2. Glass, Acrylic, and Plastic Lenses, Covers, and Other Optical Parts: (1) for each type

1.7 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturers' laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.

B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products and complying with applicable IES testing standards.

C. Provide luminaires from a single manufacturer for each luminaire type.

D. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

E. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

F. Mockups: For exterior luminaires, complete with power and control connections.
   1. Obtain Architect's approval of luminaires in mockups before starting installations.
   2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed work.
   3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
   4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering prior to shipping.

1.9 FIELD CONDITIONS

A. Verify existing and proposed utility structures prior to the start of work associated with luminaire installation.

B. Mark locations of exterior luminaires for approval by Architect prior to the start of luminaire installation.

1.10 TEST REPORTS

A. LED Luminaire IES LM-79: Test Report Submit test report on manufacturer's standard production model luminaire. Include all applicable and required data as outlined under "14.0 Test Report"

B. LED Light Source IES LM-80 Test Report: Submit report on manufacturer's standard production LED light source (package, array, or module). Include all applicable and required data as outlined under

C. LED Light Source IES TM21 Test Report: Submit test report on manufacturer's standard production LED light source (package, array or module). Include all applicable and required data, as well as required interpolation information as outlined in IES TM-21.

1.11 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures, including luminaire support components.
      b. Faulty operation of luminaires and accessories.
      c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
   2. Warranty Period: Minimum 5 year(s) from date of Substantial Completion unless manufacturers standard warranty is longer.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to ASCE/SEI 7
   1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified and the luminaire will be fully operational during and after the seismic event."

2.2 LUMINAIRE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. NRTL Compliance: Luminaires shall be listed and labeled for indicated class and division of hazard by an NRTL.

C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

D. UL Compliance: Comply with UL 1598 and listed for wet location.

E. Lamp base complying with ANSI C81.61

F. Bulb shape complying with ANSI C79.1.

G. CRI of minimum 70 unless noted and CCT of 4100 K unless noted

H. L70 lamp life of 100,000 hours.

I. Lamps dimmable from 100 percent to 0 percent of maximum light output when noted

J. Internal driver.

K. Nominal Operating Voltage: Per Drawin gs

L. In-line Fusing: On the primary for each luminaire

M. Lamp Rating: Lamp marked for outdoor use and in enclosed locations.

N. Source Limitations: Obtain luminaires from single source from a single manufacturer.

O. Source Limitations: For luminaires, obtain each color, grade, finish, type, and variety of luminaire from single source with resources to provide products of consistent quality in appearance and physical properties.

2.3 MATERIALS

A. Metal Parts: Free of burrs and sharp corners and edges.

B. Sheet Metal Components: Per Schedule. Form and support to prevent warping and sagging.

C. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses.

D. Diffusers and Globes:
   1. Acrylic Diffusers: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

E. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:
   1. White Surfaces: 85 percent.
   2. Specular Surfaces: 83 percent.
   3. Diffusing Specular Surfaces: 75 percent.

F. Housings:
   1. Rigidly formed, weather- and light-tight enclosure that will not warp, sag, or deform in use.
   2. Provide filter/breather for enclosed luminaires.

G. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
   1. Label shall include the following lamp characteristics:
      a. "USE ONLY" and include specific lamp type.
      b. Lamp diameter, shape, size, wattage and coating.
      c. CCT and CRI for all luminaires.

2.4 LED POWER SUPPLIES/DRIVERS

A. UL 8750 LED power supplies (drivers) must be electronic, UL Class 1 , constant-current type and comply with the following requirements:

B. Output power (watts) and ouput current (mA) as shown in luminaire schedule for each luminaire type to meet minimum luminaire efficacy (LE) value provided.

C. Power Factor (PF) greater than or equal to .90.

D. Total Harmonic Distortion (THD) of less than 20%.

E. Class A sound rating.

F. Operable at input voltage of 120-277 volts at 60 hertz.

G. Minimum 5 year manufacturer's warranty.

H. RoHS compliant.

I. Integral thermal protection that reduces output power if case temperature exceeds 185 degrees F 85 degrees C

2.5 ALUMINUM POLES

A. Poles: extruded structural tube complying with ASTM B 221, Alloy 6063-T6, with access handhole in pole wall.

B. Poles: extruded structural tube complying with ASTM B 221, Alloy 6061-T6, with access handhole in in pole wall.
   1. Shape: Per schedule
   2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

C. Mast Arms: Aluminum type, continuously welded to pole attachment plate. Material and finish same as plate.

D. Brackets for Luminaires: Detachable, cantilever, without underbrace.

1. Adaptor fitting welded to pole, allowing the bracket to be bolted to the pole-mounted adapter, then bolted together with stainless-steel bolts.
2. Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire. Match pole material and finish.

E. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

F. Grounding and Bonding Lugs: Bolted 1/2-inch (13-mm) threaded lug, complying with requirements in Section 260526 "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

G. Fasteners: Stainless steel, size and type as determined by manufacturer. Corrosion-resistant items compatible with support components.
1. Materials: Compatible with poles and standards as well as to substrates to which poles and standards are fastened and shall not cause galvanic action at contact points.
2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.

H. Handhole: Oval shaped, with minimum clear opening of 2-1/2 by 5 inches (65 by 130 mm), with cover secured by stainless-steel captive screws.

I. Aluminum Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" recommendations for applying and designating finishes. Shall match manufactuers fixture color exactly.
1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

J. Powder-Coat Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" recommendations for applying and designating finishes.
1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1 to remove dirt, oil, grease, and other contaminants that could impair powder coat bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, according to SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
2. Powder coat shall comply with AAMA 2604.
    a. Electrostatic applied powder coating; single application with a minimum 2.5- to 3.5-mils dry film thickness; cured according to manufacturer's instructions. Coat interior and exterior of pole for equal corrosion protection.
    b. Color: Allow for custom.

2.6 FINISHES

A. Variations in Finishes: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

B. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

C. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
   1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
      a. Color: Custom

D. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
   1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
   2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
      a. Color: Custom

2.7 Pole SUPPORT COMPONENTS

A. Utility Vault (OPAuburn) # 24R-8-LB or 24R-6-LB with conduit per drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for luminaire electrical conduit to verify actual locations of conduit connections before luminaire installation.

C. Examine walls, roofs, poles, canopy ceilings and overhang ceilings for suitable conditions where luminaires will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is substantially complete, clean luminaires used for temporary lighting and install new lamps.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Comply with NECA 1.

B. Retain first paragraph below if seismic restraint is required by local code or authorities having jurisdiction. See the Evaluations.

C. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

D. Install lamps in each luminaire.

E. Fasten luminaire to structural support.

F. Supports:
   1. Sized and rated for luminaire weight.
   2. Able to maintain luminaire position after cleaning and relamping.
   3. Support luminaires without causing deflection of finished surface.
   4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.

G. Wall-Mounted Luminaire Support:
   1. Attached to structural members in walls or Attached to a minimum 1/8 inch (3 mm) backing plate attached to wall structural members

H. Wiring Method: Install cables in raceways. Conceal raceways and cables.

I. Install luminaires level, plumb, and square with finished grade unless otherwise indicated.

J. Coordinate layout and installation of luminaires with other construction.

K. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation.

L. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and 260533 "Raceways and Boxes for Electrical Systems" for wiring connections and wiring methods.

3.4 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Section 260533 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- (0.254-mm-) thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

C. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

D. Examine poles, luminaire-mounting devices, lowering devices, and pole accessories before installation. Components that are scratched, dented, marred, wet, moisture damaged, or visibly damaged are considered defective.

E. Examine roughing-in for foundation and conduit to verify actual locations of installation.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.5 POLE FOUNDATION

A. Pre-Cast Foundations: Factory fabricated, with structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A 123/A 123M; and with top-plate and mounting bolts to match pole-base flange and strength required to support pole, luminaire, and accessories. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete."

B. Anchor Bolts: Install plumb using manufacturer-supplied template, uniformly spaced.

3.6 POLE INSTALLATION

A. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on pole.

B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on drawing.
1. Fire Hydrants and Water Piping: 60 inches (1520 mm)
2. Water, Gas, Electric, Communications, and Sewer Lines: 10 feet (3 m).
3. Trees: 15 feet (5 m) from tree trunk.

C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Section 033000 "Cast-in-Place Concrete."

D. Foundation-Mounted Poles: Mount pole with leveling nuts and tighten top nuts to torque level according to pole manufacturer's written instructions.
1. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.
2. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
3. Install base covers unless otherwise indicated.
4. Use a short piece of 1/2 -inch (13-mm) diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

E. Poles and Pole Foundations Set in Concrete-Paved Areas: Install poles with a minimum 6-inch-(150-mm-) wide, unpaved gap between the pole or pole foundation and the edge of the adjacent concrete slab. Fill unpaved ring with pea gravel. Insert material to a level 1 inch (25 mm) below top of concrete slab.

F. Raise and set pole using web fabric slings (not chain or cable) at locations indicated by manufacturer.

3.7 POLE GROUNDING

A. Ground Metal Poles and Support Structures: Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."
1. Install grounding electrode for each pole where shown
2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

B. Ground Nonmetallic Poles and Support Structures: Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."
   1. Install grounding conductor and conductor protector.
   2. Ground metallic components of pole accessories and foundation.

3.8 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.9 FIELD QUALITY CONTROL

A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.

B. Perform the following tests and inspections
   1. Coordinate "Operational Test" Subparagraph below with requirements in Section 260923 "Lighting Control Devices."
   2. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
   3. Retain "Photoelectric Control Operation" Subparagraph below for luminaires controlled by photoelectric controls.
   4. Verify operation of photoelectric controls.

C. Luminaire will be considered defective if it does not pass tests and inspections.

D. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.10 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain luminaires

3.11 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to one visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.
   1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
   2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
   3. Adjust the aim of luminaires in the presence of the Architect.

END OF SECTION 265600

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and other Conditions and Division 1 - General Requirements sections, apply to the work specified in this Section.

B. DISTRICT PROJECT CONTACT INFORMATION
   1. QUESTIONS - All questions pertaining to this document, interpretation of the document, approval of alternate materials or procedures, or items not covered by this document must be directed to one of the contacts below.

C. DISTRICT NETWORK CONTACTS - The following District staff are qualified to answer questions regarding this document and all topics that it does or should cover:
   1. Network Operations Manager - Jon Wiederspan, jwiederspan@nsd.org, 425-408-7754
   2. Network Engineer - Elizabeth Hunter, ehunter@nsd.org, 425-408-7772
   3. Network Specialist - Mike Hawker, mhawker@nsd.org, 425-408-7773

D. DISTRICT NETWORK CONSTRUCTION MANAGER - The District may employ a contractor as their representative prior to and during construction and that District Contractor may be empowered to provide answers on-site. This information will be provided prior to the start of construction.

1.2 SCOPE

A. Provide a complete communications cable distribution system composed of Ethernet (Category 5e/6/6a) and/or fiber optic cables, all components to connect, support, and protect the cables, terminations and cable connections, and associated material such as wire management panels, racks, and power management devices. This section also covers methods of installation, testing and proof-of-operation for the same.

B. Contractors will have read this document and will be familiar with the requirements that pertain to this installation, including any mentioned standards documents. A copy of this document may be obtained by contacting the Network Operations Manager by email or phone call. This document was last edited on the date shown at the top of the page and supersedes any previously edited versions.

C. Technical Questions: Any questions about acceptable substitutes, interpretation of the standard, or unspecified materials or procedures should be directed to a District Contact.

D. Acceptable Substitutions: Where specific product manufacturers, product lines, and/or part numbers are provided, no substitutions will be allowed unless specifically stated in that portion of the specifications. Where substitutions are allowed, the substitute part(s) must be prior approved by a District Contact

1.3 CONTRACTOR QUALIFICATIONS

A. The following qualifications are required for the prime contractor and any subcontractors involved in this project who will be working on communications cable installation or testing. Contractors may be required to provide proof of certification.
   1. Certification and Training Requirements: Anyone working on communications cable installation must meet the requirements below.
      a. Anyone working with fiber optic cable must have a CFOT or CFOS from FOA or a BICSI INST1 or INSTF Certificate.
      b. At least one person working on the fiber optic cable installation must have either an FOA CFOS or BICSI INSTF certificate OR have a minimum three (3) years of experience primarily working on data cabling installations.
      c. At least one person working on the copper cable installation must have either an FOA CPCT or BICSI INSTC certificate OR have a minimum three (3) years of experience primarily working on data cabling installations.
   2. Communications Cable Installation Warranty:
      a. The contractor will warranty the communications cable system for three (3) years after installation from any defect in material or installation. The warranty period will begin on the date of the Owner's acceptance of the work. Quality and workmanship evaluation will be solely by the Owner or Owner's designated representative.
      b. The contractor will obtain any training or certification required by cable manufacturers in order to meet the manufacturer requirements for the product warranty.
   3. Contracting Company Relevant Experience: Any company contracted to work with the communications cable must have been operating for at least three years as a company primarily providing communications cable installation.
   4. Pre-Construction Meeting: Each contracted or sub-contracted company who will be working with the communications cables is required to have at least one person attend a pre-construction meeting, which will be scheduled at least ten working days prior to the start of installation. The person attending must be present during all work by that company with the communications cable system. Any change in these personnel must be approved by the District and will require the new person to conduct a walk-through of the communications cable system with a District Technology contact.
      a. Roles and Responsibilities: At the pre-construction meeting, each contractor or sub-contractor will need to provide District staff with full contact information and a description of their role and responsibilities in the project.

PART 2 - PRODUCTS

2.1 EQUIPMENT RACKS

B. Floor-Mounted Telecommunications Rack: Full-height two-post racks will be CPI #46353-503-X03, 84'H x 19'W ,45U
   1. Cable Management: Single side vertical cable management for racks will be CPI #12096-503. Double-sided vertical cable management between racks will be CPI #11729-503. Horizontal fiber cable management will be CPI either #12183-719 or #13183-719 depending on necessary bend radius which will be specified in drawings. Cable Spools for vertical fiber cable management will be installed inside of the vertical cable management tray and will be CPI #12766-707.

C. Floor-Mounted Telecommunications Cabinet: Full height cabinets will be Tripp-Lite #SR2400 ,POWER PROTECTION STRIPS: Each rack or cabinet will be equipped with one power protection strip Tripp-Lite PDUMH20-ISO or approved equivalent.

2.2 RACEWAYS AND CONDUITS

A. Cable Tray/Ladder Rail - Gray, 1.5”H x 15”W x 9’-8.5”L (Chatsworth 11275-015 or approved equivalent)

B. Innerduct - orange, 1.25”, plenum corrugated (Anixter 249416, or approved equivalent)

C. Pull String – Wherever a “pull string” is required, the product may be either a pull string or mule tape and will have a tensile strength of not less than 300 pounds.

2.3 OUTSIDE PATHWAYS

A. Innerduct - orange, 1.25”, plenum corrugated (Anixter 249416, or approved equivalent) – NOT for use in direct UV exposure.

B. Tracer Wire - #12 solid copper tracer wire with orange jacket, HMWPE insulation, UL 600V. We do NOT allow stranded tracer wire.

C. Vault
1. Any vault used will be labeled “NSD Communications” on the lid.
2. Any vault that will be in a roadway which may have vehicles over 1 ton in weight will have a traffic grade round steel lid. Specific lid requirements will be identified in drawings.

2.4 MODULAR COPPER TERMINATION PANELS

A. Termination Panel Products - Contractor will recommend termination panels for terminating Category 5e and Category 6a copper cable that meet the warranty requirements for the cable being installed. Recommendations will be submitted to District Network staff for approval before purchase. All jacks in termination panels will be flat (not angled).

2.5 FIBER OPTIC TERMINATION PANELS

A. Campus (LAN) Fiber Patch Panel:
1. The Fiber Optic Patch Panel will be Corning CCH-0nU (where n is units of height for the panel) or an approved equivalent, with the requirement that the same panel manufacturer be used throughout the construction project.
2. All fiber optic cable termination panels will use cassettes for termination that are compatible with the Corning CCH panels.
3. Termination panels must be appropriate for the types of fiber optic cables that will be terminated in the panel, allowing for the appropriate bend radii and the volume of the incoming fiber cables so the panel will operate as designed by the manufacturer.
4. All ends will be UPC/LC duplex terminations and will be blue.
5. Termination panels must include cable management components.
6. Termination panels must be equipped with a fiber breakout for managing slack fibers within the unit.

7. Termination panels must be equipped with strain relief brackets which must be used to secure cables entering and exiting the panel and will be appropriately sized for the type of cables entering the termination panel.

2.7 DATA CABLES

A. Campus Fiber Optic Cable: All Fiber Optic Cable installed on campus (not WAN cable) will meet all specifications below:
   1. Cable will be indoor/outdoor rated, single-mode (OS2), loose tube, gel-free
   2. All fiber optic cable shall meet all applicable standards as specified in ANSI/TIA/EIA 568-D.3 or newer.
   3. Cable will be Interlocking Armored plenum cable, unless otherwise specified by District staff.
   4. All armored cable will be grounded to any cabinet where it is terminated.
   5. Recommended cable will be Corning or OFS, but approved equivalents are allowed.

B. Data, Security, Intercom: Interior Category 5e/6 Cable: Where Category 5e cable is allows, Category 6 cable may also be used if it proves more cost effective for the project. All Category 5e/6 Cable installed will be the same manufacturer and brand with white outer jacket color meeting all specifications below:. Intercom cable will be orange color

   1. Access Control: Provide a 4#18 access control power cable with the above data cable to all door controller locations denoted by a data outlet with an A next to it.

      a. Lock Power 18 7x26 BC - Bare Copper Belden 5322UE or as recommended by the access control vendor

C. Cable will be unshielded, twisted-pair.
   1. Cable will be listed in the UL Verified LAN Cable Products Directory as complying with 5e/6 requirements and bear the category performance marking: “Verified (UL)”.
   2. Cable shall meet all applicable standards as specified in ANSI/TIA/EIA 568-C.2 or newer.
   3. The cable manufacturer will test and provide, with each 1000-ft. spool/box, a factory certified test report guaranteeing each spool/box complies with the standards required in this document.
   4. Cable will be approved for installation in spaces used for environmental air handling when installed in accordance with NEC Article 300-22.

D. WAP - Interior Category 6a Cable: All Category 6a Cable installed will be the same manufacturer and brand with light blue outer jacket color meeting all specifications below:
   1. Cable will be listed in the UL Verified LAN Cable Products Directory as complying with Category 6a requirements and bear the category performance marking: “Verified (UL) Category 6a”
   2. All category 6a cable shall meet all applicable standards as specified in ANSI/TIA/EIA 568-C.2 or newer.
   3. Preferred product is the Hitachi Supra 10G XE UTP Category 6a cable, but approved equivalents are allowed. Cable will be unshielded unless shielding is required by design.
   4. The cable manufacturer will test and provide, with each 1000-ft. spool/box, a factory certified test report guaranteeing each spool/box complies with the standards listed above.
   5. The contractor will furnish the original factory test reports from each spool/box to NSD prior to any installation of the cable.

E. OSP Category 6a UTP Cable:

1. Cable for “outside plant” or conduit installation outside of or underneath a building will meet all other requirements for Category 6a cable in this document, except that it will be CMX- or CMP-rated for indoor/outdoor use.
2. "Gel-filled" cable is not allowed for use on the District network.

F. COPPER DATA OUTLETS
1. Data, Security, Intercom - Category 5e/6 Data Outlets: All data outlets will be wired with the TIA 568A pattern and will be flat face (180 degree, not angled) and will be ETL verified to Category 5e component specifications. Preferred product is Ortronics OR-40300158 single-gang with Category 5e rated OR-60950009 dual jacks as required or an approved equivalent. Provide blank modules, OR-40300023 Series II Blank Module, 1.5. to fill empty spaces in the faceplate.
2. WAPS - Category 6a Data Outlets: All data outlets will be wired with the TIA 568A pattern and will be flat face (180 degree, not angled) and will be ETL verified to Category 6a component specifications. Preferred product is Ortronics Clarity Cat6a TracJack, T568a/b, fog white, 180 degree or approved equivalent. Provide biscuit jack with 10 foot loop of cable

PART 3 - DESIGN

3.1 COMPLIANCE

A. Regulatory Requirements: All communications cable installations will comply with: Current NEC as applicable to construction and installation of cables, wires and connectors; The Uniform Building Code; Local utility practices and agreements; State, city, and county ordinances and statutes having jurisdiction regarding this project; and ICBO Standards (regional office 12505 Bellevue-Redmond road, Bellevue, WA 98005).

B. The following copper standards will be required for this project:

C. NEC Compliance: All installations will comply with the requirements of ANSI/EIA/TIA
1. ISO/IEC 8802-3 (IEEE 802.3) IEEE Ethernet Standards
2. 568-A and 568-B Commercial Building Telecommunications Cabling Standard
3. 568-C.1 Commercial Building Telecommunications Standard for Enhanced performance for Cat6 and Cat6a twisted pair cable systems
4. 568-C.2 Balanced Twisted Pair Telecommunications Cabling and Components Standard
5. 569-C Commercial Building Standard for Telecommunications Pathways and Spaces
6.

D. The following fiber optic cabling standards will be required for this project:
1. NEC Compliance: All installations will comply with the requirements of ANSI/EIA/TIA
2. 568B.3-2000 Optical fiber cabling components standard
3. 568 C.1 and C.3 - Factory test of 100% of fiber strands. (Use TIA 526-7 for single mode fiber).
4. 455-107 (1999a) FOTP-107 Determination of component reflectance or link/system return loss using a loss test set.
5. 472E000 Standard for indoor/outdoor optical fiber cable
6. 455-78-B (2002) Measurement methods and test procedures
7. 526-7 Single mode attenuation testing
8. NECA/FOA 301 Installation and testing of fiber optic cables 3

3.2 PATHWAYS

A. Pathways for Network Backbone Cables (MDF/IDF Interconnections)
1. All copper and fiber optic cable runs between and MDF and IDF or IDF and IDF will be continuous and uninterrupted between the two locations, unless interruption is required for lightning protection.
2. All IDF locations will have copper and fiber optic cables provided directly from the MDF unless approved by District Network staff to feed from another IDF. In general, IDF to IDF connections are only allowed for small network rooms supporting two or fewer network switches and only with approval from the Network Operations Manager.

B. Raceways and Conduits
1. Conduit pathways between MDF and IDF locations shall be 4” conduits with three 1.25” innerducts, each equipped with pull string,
2. Any pull string installed in conduits or innerducts will be long enough to extend beyond the end of the conduit or innerduct on both ends such that it can be attached to a fixed object.
3. Fiber optic and copper cables should share a common pathway where possible.
4. All cables running through buildings will be in conduit or cable trays, unless space restrictions prohibit their use, in which case cables will be supported with cable saddles (for up to 10 cables) or J-hooks (for 11 or more cables) using Caddy CAT21 hooks with Part No. #CATHBA brackets.
5. Cable fill percentage will be based on NEC standard and on the cable manufacturer’s published recommendations for warrantied installations.
6. All fiber optic cable running through buildings should be in conduit or cable tray. When noted on a drawing that a fiber optic cable is supported above ceilings or in attics without conduit or cable tray, the cable will be run in innerduct unless it is armored cable specifically designed to run without innerduct.
7. Conduits that are concealed above non-accessible ceilings, in walls, etc., will be continuous from outlet location to cable tray location.

C. Underground Cable Pathways
1. Underground runs of network cable will always be installed in suitable underground conduit or duct bank. In no case will network cable be directly buried.
2. New underground conduit will be installed 36” or more below the surface, except in transition spaces to/from a handhole, vault, riser or similar situation. If cable will be pulled into existing conduit that is less than 36" below the surface then the conduit must either be relocated to 36” or more below the surface OR it must be relocated to at least 24” below the surface and protected with CDF (or FTB that provides equivalent protection) wherever it passes underneath a sidewalk, a road surface, or any unfinished surface where it would see traffic from vehicles weighing 1000 lbs. or more.
3. All underground conduit runs more than 100’ in length between MDF and IDF must be intercepted by at least one handhole/manhole capable of containing a 100’ cable slack. Exceptions may be made in the case of outlying buildings with very little network infrastructure with approval from a District Contact.

3.3 CABLE

A. Fiber Optic Cable
1. All fiber optic cables will be designed in continuous lengths from fiber patch panel to fiber patch panel.
2. A 50' cable service loop will be provided for each MDF or IDF in addition to any service loop inside the fiber termination panel. The service loop may be located on the backboard or overhead raceway.

3. All fiber optic cable installation will follow all of the manufacturer's recommendations for proper handling, specifically including minimum bend radius and maximum applied tensile stress force.

B. Copper Cable
1. All copper cables will be designed in continuous lengths from the data outlet to patch panels at the MDF or IDF locations. In no case may the cable be terminated on a consolidation point, or otherwise interrupted in the run between the MDF or IDF and the final outlet or termination, unless "lightning protection" is required by code.
4. The maximum stacked height of copper cables in any cable tray will take into account the cable manufacturer's installation instructions and heat dissipation requirements for anticipated PoE use in the cables, and will not be more than 2-½" deep.
5. Each copper cable will have a 36" service loop in each IDF or MDF. The loop will be placed in cable tray, or on backboard if a cable tray is not present.
6. Each copper cable will have an 18" service loop located as close as possible to the outlet.

3.4 OUTLETS

A. All Copper Outlets
1. Single-gang device plates will be limited to a maximum installation of four jacks. Provide multi-gang plates where more than four jacks are required by design.

3.6 INTERCONNECTIONS BETWEEN NETWORK ROOMS (MDF/IDF)

A. FIBER INTERCONNECTIONS: Every IDF will have a minimum 12-strand fiber optic cable connection to the MDF, except for "mini-IDF" locations that are approved to cascade from another IDF. An IDF may need a higher fiber strand count installed if that location will support other "mini-IDF" locations or higher than usual cable counts. A "mini-IDF" location may be approved by Technology for a 6-strand fiber connection, depending on how many network connections it will be supporting. Modifications from the 12-strand standard must be approved by Network Operations Manager.

B. COPPER INTERCONNECTIONS: Every IDF will have a minimum of two Cat5e connections to the MDF, except for "mini-IDF" locations that are approved to cascade from another IDF. An IDF may need a higher copper cable count installed if that location will support other "mini-IDF" locations. A "mini-IDF" location may be approved for a lower copper cable count, depending on how many classrooms it will be supporting. Modifications from the four copper standard must be approved by Network Operations Manager.

PART 4 - EXECUTION

4.1 COMPLIANCE

A. Regulatory Requirements: All communications cable installations will comply with: Current NEC as applicable to construction and installation of cables, wires and connectors; The Uniform Building Code; Local utility practices and agreements; State, city, and county ordinances and statutes having jurisdiction regarding this project; and ICBO Standards (regional office 12505 Bellevue-Redmond road, Bellevue, WA 98005), as well as all manufacturers' installation instructions and best practices for all material.

4.2 RACEWAY/PATHWAY/CONDUIT INSTALLATION

A. Underground Cable
   1. All underground cable will be run in suitable underground conduit or duct bank. In no case will cable be directly buried!
   2. All underground conduit or ducts that extend beyond the perimeter of the building will include the installation of a 12-gauge tracer wire for locating services. The tracer wire will be installed with enough extra wire to extend at least three feet out of the underground entrance. If the entrance continues up a riser pole, the tracer wire will be long enough to reach the ground from its exit from the riser pole.
   3. In any hand hole or vault, the tracer wires need to be left in a location that is easily accessible by a locator with enough extra wire to extend at least three feet out of the hand hole.
   4. Any “pull string” installed in conduit or innerduct must extend beyond each end and be attached to a fixed object.

B. Interior Pathways
   1. If a pathway calls for cable saddles or J-hooks, cable supports will be permanently anchored to the building structure or substrates. The installer will provide attachment hardware and anchors designed for the structure to which attached, and that are suitably sized to carry the weight of the cables to be supported. Cables are not allowed to be supported from a ceiling tile suspension grid.

C. General
   1. Cables will not be installed in conduits until bushings are installed on the ends of the conduits.

D. RACK and CABINET INSTALLATION
   1. Common Ground
      a. A ground terminal block will be provided in each IDF and MDF. Installation will include all required bonding material and hardware. All ground bars will be bonded to the building grounding electrode subsystem at the building electrical service entrance.
   2. Cabinets and Racks
      a. All racks will be grounded using stranded, insulated copper conductor, routed overhead to the Common Ground terminal block. Ground wire will be terminated on an aluminum ground terminal block on the cabinet or rack. When multiple cabinets or racks are installed in a single room, each will have an individual ground connection to the Common Ground.
      b. Grounding and bonding should be completed as per ANSI/TIA/EIA 607.
      c. One vertical cable management panel, CPI #12096-503, will be installed on the outside rail on each side of all racks. Where more than one rack is installed in a single location, a CPI double vertical rack cabling section CPI #11729-503 will be installed between each rack and a single vertical cable management panel (as above) on the outside rail of the two end racks.
      d. Any floor-standing rack or cabinet will be secured to the wall or an adjacent backboard with a cable tray having no less than two lag bolts into the wall or backboard.
      e. Any floor-standing rack or cabinet will be secured to the floor with a minimum of four bolts, one for each corner/side.

E. Raceways and Cable Trays
   1. This section left as a placeholder

F. Termination Panels
   1. All copper termination panels will be terminated according to the color pattern T568A and adhere to the performance requirements specified in 1.3.A.1 (above).
   2. Copper Patch panels will be installed on equipment racks as specified in Part 5 TYPICALS Diagram 1 (MDF/IDF Two-Post Rack) and used for termination of all data cables at IDF's and MDF's below any fiber patch panels. Panel port count will be as noted on drawings. Where port count is not noted, provide one port for each jack on each wall outlet plus a minimum of 10% spare for each IDF or MDF.
   3. When installing fiber optic cable in a termination panel, the contractor will secure the cable with strain relief brackets where the cable enters the panel.
   4. Contractor will dress in slack fibers within the unit according to manufacturer’s instructions for the termination panel so that the panel can be fully opened and extended without damaging the fibers. Contractor will leave a minimum of 24” of unsheathed cable in the termination panel.
   5. Contractor must install cable management for the fiber termination panel according to manufacturer’s instructions.

G. FIBER OPTIC CABLE INSTALLATION AND TERMINATION
   1. Fiber Optic Cable Installation
      a. The cable-bending radius during installation will be limited at all times to no less than 20 times the diameter during installation.
      b. The installer will provide all required tools, materials, consumables, and equipment necessary for field mounting of UPC/LC or aPC/SC connectors as defined in the design drawing.
      c. All fibers will be terminated in a consistent, consecutive color-coded manner at each end.
   2. Fiber Splicing and Termination Requirements
      a. The Contractor shall splice and terminate the cable using a core alignment fusion splicer and precision cleave tool.
      b. The Contractors fusion splicing equipment shall be cleaned, calibrated, warmed up for a minimum of 5 minutes prior to operation and adjusted to the fiber and environmental conditions at the start of the job
      c. The Contractors fusion splicing equipment shall be checked daily and readjusted if necessary.
      d. Splicing shall be done only at the patch panels for splicing pigtails or as shown on the construction drawings
      e. Only test equipment that has been calibrated within the last 12 months from the start of the job will be allowed and available to perform testing.
      f. Contractors must provide proof of calibration to the District engineer before testing can begin.
      g. The calibration label must be displayed on all equipment showing the dates of calibration.

H. UTP COPPER CABLE INSTALLATION AND TERMINATION
   1. The installer will provide all necessary installation materials, hardware, tools and equipment to perform insulation displacement type terminations at all data outlets and patch panels. All wires will be terminated with a 110-type punch down tool.
   2. All cable terminations will be in the color pattern for T568-A.
   3. All data jacks within a room will be terminated on the patch panel in sequence such that the jack number increases sequentially around the room in a clockwise direction starting from the door. If a patch panel is filled, then the terminations will begin in the next sequentially numbered patch panel. Where there are two or more jacks in a faceplate, the sequence will start at the top left and finish at bottom or bottom-right. In an overlay (where there are already existing jacks), the new numbering will only take into consideration new

jacks being installed in the room. Wherever possible, numbering will continue sequentially in a logical pattern to neighboring rooms. Cables installed in the ceiling will be numbered after those in the wall within a room.

4. Install UTP Cables in continuous lengths from the data outlet to patch panels at the MDF or IDF locations. In no case may the cable be terminated on a consolidation point, or otherwise interrupted in the run between the MDF or IDF and the final outlet or termination, unless “lightning protection” is required by code.
5. The installer will provide a 36" service loop for UTP cables at each IDF or MDF. The loop will be placed in cable tray above the ceiling or on the backboard for wall mount units.
6. Any tie-wrap, “zip” tie, Velcro wrap or other restraint used on cable bundles will be loose enough to slip along the cables and will not deform the outside jackets of the cables.
7. Cables will be bundled according to design specifications and an manufacturer’s installation instructions and will not exceed 50 cables in a bundle.
8. Cables will not be crimped or bent into a tighter radius than recommended by the manufacturer.
9. The maximum spacing for supports for cables in free air will be 36"
10. All copper cables in an IDF or MDF will have a 50’ service loop dressed into the cable tray or on the backboard.
11. All other copper cables will have an 18” service loop located as close as possible to the outlet.
12. All wall jacks and other cable terminations outside of the IDF or MDF will be completed in compliance with the jack manufacturer’s installation instructions and applicable requirements of the NEC.
13. Install jacks only in electrical boxes that are clean, free from dirt and debris. At cut-in locations, a cut-in box is required – a cut-in ring only is not acceptable.

I. LABELING

1. TAPE LABEL: Identification labels will be produced using a labeling system that provides clear, readable lettering and adhesive backing. Unless otherwise specified, labels will be black lettering on white tape of consistent font size and style that is readily visible when viewed from four feet away from the label.
2. Fiber Optic Cable Labels:
   a. Fiber optic cable will be labeled as to source and destination in each Vault, Handhole, or J-box using cable ID marker plates.
   b. Fiber optic cable will be marked within 12 inches of where it enters or exits any conduit with orange or red labels stating "Caution- Fiber Optic Cable". Labeling products will be as selected by installer.
   c. Each end of each fiber optic cable terminated on a fiber optic patch panel will be labeled as to its destination using Panduit marker plates placed on the cable in the service loop just before the termination panel.
3. Fiber Patch Panels - Patch panels will be labeled on the front face next to the connectors with one label per termination faceplate with the termination numbers for that faceplate in the pattern <termination panel number>:<port number of lowest numbered port in faceplate>-<port number of highest numbered port in faceplate>
4. Copper Interconnect Cable – All copper cables between MDF and IDF locations (interconnect) will be labeled at each end with “Cross-Connect”, the IDF number of the far end termination location, and a sequential number in the pattern Cross-Connect-<IDF number>-<cable number>.
5. Copper Patch Panels - Copper patch panels will be labeled on the front face in the top-middle of the panel (or closest space available) in the pattern <MDF/IDF number>-<Panel number> starting with “1” for the first copper distribution patch panel in the left-most rack and continuing sequentially through all copper distribution patch panels in the room.
6. COPPER CABLE JACK: All copper jacks will be labeled with the MDF/IDF number, patch panel number and port number, e.g., 2-2-36 (IDF 2, patch panel 2, port 36). Cables

terminated with a male RJ45 jack will be labeled with a wrap-around label 4" from the termination.

7. ABOVE CEILING CABLE: Where copper cables are terminated loose above the ceiling, identification labels will be placed on ceiling grids at the location of the cable and will use white lettering on 1" wide black tape with a font that fills at least 2/3 of the tape width.

J. TESTING

1. Copper Data Cable Testing
   a. Test Method and Reporting: All UTP wiring will be certified to meet or exceed the specifications as set forth in the Link Performance Testing Specifications For Field Testing Of Unshielded Twisted-Pair Cabling Systems, TIA/EIA TSB-67 level II, for Category 5E links. Certifications will include the following parameters for each pair of each cable installed:
      1) Wire map (pin to pin connectivity)
      2) Length (in feet)
      3) Attenuation
      4) Crosstalk (NEXT)
2. Fiber Optic Cable Testing
   a. Test Method and Reporting: Contractor will test cable to OTDR standards for both 1310nm and 1550nm. Contractor will furnish Owner with electronic copies of all test results with at least the following information:
      1) Date of test
      2) Name of test personnel
      3) Test wavelength
      4) Pulse duration(s) and scale range(s)
      5) Index of refraction
      6) Fiber cable types and parts number
      7) Fiber tube and/or fiber strand number
      8) Direction of test
      9) Overall distance in meters
      10) Attenuation dB or dBm
3. Pre-Installation Testing: The Contractor shall test each individual fiber in a cable with an OTDR for length and transmission anomalies while on the reel after fiber is delivered to the site and prior to installation.
4. Post-Installation Check: The contractor shall review all end faces of field terminated connectors with a fiber inspection scope following the final polish. Connector end faces with hackles, scratches, cracks, chips, and/or surface pitting shall be rejected and re-polished or replaced if re-polishing will not remove the end face surface defects. The recommended minimum viewing magnifications for connector ends is 200X for single-mode fiber.
5. Post-installation Testing: The following tests will be done after the fiber is installed and terminated:
   a. Test reference cable(s) shall be verified each day with tests saved and submitted along with fiber strand tests.
   b. All fiber strands shall be tested end-to-end for bi-directional attenuation at 1310 nm/1550 nm for single-mode fibers. Tests should be conducted in compliance with EIA/TIA-526-14 or OFSTP 14, Method B, according to the manufacturer's instructions for the test set being utilized.
   c. Tests must ensure that the measured link loss for each strand does not exceed the "worst case" allowable loss defined as the sum of the connector loss (based on the number of mated connector pairs at the EIA/TIA-568 B maximum allowable loss of 0.75 dB per mated pair) and the optical loss (based on the performance standard above in 4.3.C.1).
   d. After termination, each fiber shall be tested with an OTDR for length, transmission anomalies, and end-to-end attenuation.

e. After bulkhead mounting, each terminated fiber is to be tested for end-to-end loss with a power meter/light source.
f. The maximum allowable attenuation for any splice or termination is 0.3 dB.

K. TESTING SCHEDULE
1. Testing Notification and Scheduling: Network Operations Manager must be notified when at least 25% of the copper or fiber cable terminations are completed and prior to any final testing by the contractor. At that point the Owner's Technology representative will inspect the work in progress to check for adherence to installation standards. No portion of testing may be done until all cabling for that IDF or MDF location is complete, unless the location involves more than one rack in which case the testing for a rack may begin once all cabling for that rack is complete.
2. Owner Independent Testing: Owner may choose to perform independent testing to spot-check the test results. If more than 10% of circuits tested fail the testing, the Contractor will be required to retest the entire system. If fewer failures occur, Contractor will be required to make individual repairs and retest.
3. Owner Verification: Before final acceptance, the Owner will spend a minimum of one day at the job site to verify the installation and operation of the communications cable system in actual practice.
4. Submittal: The test equipment used must provide an electronic record of these tests. Contractor will provide all test results to the Owner at the completion of the testing as stated in 4.5.C (below).

L. RECORD DRAWINGS AND DOCUMENTATION
1. SUBMITTALS
a. Test Results: At the completion of the testing, provide the owner with the final test results for each fiber optic and Category 5E cable installed. Test results will be provided on a CD in a format readable by Microsoft Word or Excel or transferred electronically per directions from District Network staff. One copy of the test results will be marked for District Network staff.
b. Factory Test Results: Contractor will provide District Network staff with the original factory test reports from each spool or box of communications cable used on the project.

END OF SECTION 271500

PART 1 - GENERAL

1.1 GENERAL DESCRIPTION

A. Description: For purposes of this specification, a distributed antenna system is an in-building wireless system facilitating frequencies as required by King County and City of Kenmore for the new building. The system antenna design and layout shall be designed and configured for coverage and accessibility per 2015 IFC standards as modified by Kenmore and King County. Contractor shall coordinate with and contact Kenmore and King and provide all frequencies (UHF and/or VHF) required by the county.

B. This specification requires the installing contractor to design the system, coordinate all installation requirements with the general and electrical contractors and provide all equipment necessary for a complete and fully functional system. Drawings do not show cabling, raceways, or any other provisions for the system. Contractor shall include all required for the system.

C. Provide a complete functional turn-key system, ready for owner's use. System shall be equal to Commscope Andrew

D. The DAS system shall comply with the following design, coverage and reliability requirements:
   1. Signal Handling
      a. The system shall have active powered elements that filter and amplify signals on a band specific basis to consistently deliver wireless services at the appropriate power levels. The system shall have the flexibility to support all requested services with separate amplifiers to ensure that the power levels for each band or service may be individually adjusted without disturbing the level of the other services. If active powered elements are not required on the system, the bidder must show engineering details (e.g. power budget) for both upstream and downstream for every required frequency band specified in this specification.
   2. Backbone Transport
      a. The system may utilize single mode fiber optic interconnects to distribute signals between active devices between floors or building sections.
      b. The system may also utilize coaxial cable to distribute signals between floors or building sections.
      c. Use only single mode fiber optics for transports for the connection from the roof top source signal donor antennas to the DAS comm. room on the first floor.
   3. Broadband Distribution
      a. The system shall utilize coaxial cable in the horizontal runs, and passive, broadband antennas in the distribution area. Bidder shall provide antenna specifications, including frequency range, physical dimensions, and electrical specifications, for each antenna proposed.
   4. Multiple Services
      a. The system shall have the capability of providing different services and power levels across the building in order to provide service flexibility to the end users
   5. Backup Power
      a. 24 hr backup power is required. All DAS electronics shall be provided with battery backup

1.2 CONTRACTOR/INSTALLER

A. Contractor shall have been in business for a minimum of 10 years installing low voltage systems.

B. Contractor shall have completed design and installation a minimum of 3 emergency responder systems

C. Contractor shall have the experience of installing a minimum of (5) wireless networking systems in schools of similar size to this project.

1.3 MULTI SERVICE FLEXIBILITY

A. Broad Range of Service
   1. The system shall be capable of supporting the following spectrum, services, applications, and technologies.
      a. Public Safety systems or as required by the Kenmore and King County Fire Marshal
   2. System Overview
      a. Head End
         1) The radios DAS head end equipment will be located in the MDF located in the MDF shown on the drawings.
         2) Bidder shall specify and quote the necessary equipment to connect the head end equipment with the equipment located in MDF or IDF's in the building.
         3) Provide Nema 4 enclosed wall or floor mounted rack with ventilation fan
         4) At a minimum, include Bi-Directional Amplifier (BDA) equipment for each of the supported bands, as well as suitable active or passive combining equipment as required combining the multiple signals into a single system.
         5) IEEE 802.11 a/b/g/n wireless LAN systems will not be part of the Distributed Antenna System design.
   3. The area of the building that requires DAS consists of the entire school. See the floor plans for exact layout and square footage but the code summary includes the following table. The contractor shall be responsible for confirming exact square footage.
   4. Drawings show the communications riser and pathways to the IDF.
      a. DAS room shall connect to the MDF/IDF system via the MDF.

B. Wireless Service Performance
   1. The primary role of the DAS system is to ensure public safety radio communications system work in the coverage area. As such, reliability should be a primary goal of the design.
   2. Signal Sources
      a. Minimal roof top space is available. Antenna locations and mounting requirements must be coordinated with the school district.
      b. The external and internal antenna locations must be approved by the owner and design team.
      c. The design and topology of all other equipment locations and cable pathways should minimize the impact of any single point of failure.
      d. Signal sources shall be coordinated between the wireless carriers and the school district in bringing in the wired circuit, if required.
   3. DAS Loading
      a. Public safety channels for all systems designated by King County
      b. Link Budgets
         1) Bidder shall provide detailed link budgets for each band used by wireless operator that will be injected into the DAS.

2) Bidder shall provide a detailed link budget for each segment of the DAS.
3) Bidder shall provide link budgets for both downstream and upstream within the DAS.

4. Coverage Design
   a. Provide a minimum system signal level design to meet 2015 IFC and King Requirements
5. Interference
   a. Bidder shall guarantee that there will be no interference between the services within the DAS, or between the DAS and wireless carriers
   b. Bidder shall describe in detail the methods that have been undertaken with the product to ensure that interference is minimized.
6. Location of Active Elements
   a. If Active elements are required, the system shall have all active elements (remote units) located in comm. room and DAS room.
   b. Location of active elements in the ceiling is not acceptable.

C. Other Bid Requirements
1. If fiber optic cable is utilized, Bidder shall specify the final quantities of fiber required, as well as the fiber characteristics required (single mode, multiple mode, loss profile, termination types, etc.) for:
   a. Connectivity between BTS/BDA and head-end, and
   b. Connectivity from head-end to local IDF/hub locations.
2. If coaxial cable is utilized, Bidder shall specify the final quantities of coax required, as well as the coaxial cable characteristics required (cable size, loss profile, termination types, etc.) for:
   a. Connectivity between BTS/BDA and head-end, and
   b. Connectivity from head-end to local IDF/hub locations.

1.4 MANAGEABILITY

A. The ability for proactive management and end-to-end alarming results in rapid problem identification and resolution. Therefore, it is important that the in-building system be managed. The system shall include a centralized management system and alarm monitoring and notification system. The bidder shall provide a detailed compliance statement for the following requirements.
1. End to End Visibility
   a. The management system shall have the capability to provide end-to-end status information from the headend/BDA/BTS to the remote-end, including the antennas.
2. SNMP Integration
   a. In a hybrid or an active distributed antenna system, the system shall engage with 3rd party SNMP based element management systems and provide fault management information for any active devices that have.

1.5 SUBMITTAL REQUIREMENTS AND PROPOSAL SCHEDULE

A. Submittal Format
1. Respond to all sections in this specification with one of the following responses:
   a. Comply with Specification
   b. Partially comply with Specification
   c. Do not comply with Specification

B. Proposal Technical Documentation Design Submittal Requirements

1. The following technical documentation is required as part of this proposal submittal. This documentation will be used by the architectural design team to provision space, cooling, and electrical loads for the components of the internal DAS system, in addition to the shop drawings and specifications detailed in this document. Reference the specifications included in this specification for additional information and requirements.
2. Component List
    a. Provide a summary list of components required for system operation in Excel format. This list must include the part number, line item cost, and a brief description of the component. Immediately following this information, provide information regarding the location where the device is to be installed. Include a column indicating the infrastructure requirements for each component as well, as follows:
        1) Electrical Requirements
        2) Mechanical Requirements
        3) Cabling Requirements
        4) Mounting Requirements
3. System Block Diagram
    a. Provide a block diagram illustrating system components and connectivity requirements.
    b. At a minimum label: cabling requirements, electrical requirements, and related system components. Include a high level diagrams for Comm Room, DAS Room (head end), and rooftop antenna areas or any other related space.
4. Installation and System Support
    a. The installation shall be performed by a company that has been in the business of installing DAS systems for a period of at least three years. The bidder shall provide installation references as required in the request for proposals
    b. The Bidder shall fully describe the proposed DAS system support methodology and resources. A baseline support program shall be proposed, which is appropriate to public safety operations.
    c. For purposes of evaluating proposals, initial restoration response for remote diagnostics shall be within two hours, on site diagnostics within 8 hours, and parts availability / service restoration within 24 hours.
    d. The bidder shall provide installation references as required in the request for proposals
    e. The bidder must be factory trained and supported by equipment manufacturer
    f. The bidder must have at least one engineer possessing an FCC General Radio Operators License and
    g. The bidder must have at least one technician possessing an Electronics certification from NARDA, APCO or ETA in Wireless communications
    h. Firm must possess proper calibrated test equipment including a spectrum analyzer or control radio, signal generator and cable sweep analyzer. Instrument operator must hold certification on instrumentation used.

C. Warranty Requirements
1. Provide a sample warranty as part of this submittal for each of the sections detailed below.
    a. Hardware Warranty
        1) The system selected will require a 5 year parts warranty.
        2) All costs associated with extending the parts warranty to the 5 year period will be included in the base system.
        3) Any additional service contracts required shall be listed as individual line items.
    b. Labor Warranty
        1) The system selected shall require a 2 year labor warranty.

2) All costs associated with extending the labor warranty to the 2 year period will be included in the base bid.
3) Any additional service contracts required will be listed as individual line items.

1.6 PROJECT SUBMITTALS AND SHOP DRAWINGS

A. Product Submittals:
1. Provide in a three ring binder with hardboard covers.
2. Provide with index and divider tabs by Specification section.
3. Indicate Specification paragraph number on all documents.
4. Review and check all material prior to submittal and stamp "Reviewed and Approved".
5. Submittals shall include:
a. Product Data for all items provided under this Section.
1) Indicate materials, finishes, load ratings, dimensions, listings, approvals and attachment methods.
2) Indicate how the components of an item or system are assembled, interconnected, function together and how they will be installed on the project.
3) Highlight with yellow or blue marker, or indicate with arrow stamp, adequate information to demonstrate materials being submitted fully comply with contract documents.
4) Indicate listing by UL or other approved testing agency.
b. Manufacturers' Cable Installation Instructions

B. Shop Drawings
1. Provide detailed plan views (minimum scale 1/4"=1'-0") and elevations of the DAS room and comm. room showing field conditions, ancillary room components, dimensions, equipment racks, termination blocks, patch panels, cable paths and workspace requirements for access to equipment and cable connections.
2. Ratings of items.
3. Coordinate with other division shop drawings and submittals. Identify interface points and indicate method of connection.
4. Provide drawings to show evidence of coordination with other trades.
5. Provide plan drawings of each floor of each building showing:
a. Routing for all cables installed under this Work.
b. Pathways of all cable supports with part number, total capacity, and installed capacity for each support or run of supports.
c. Antenna locations
6. Reports and Schedules
a. Provide Cable Termination Schedules for all cables installed under this work, with the following information:
1) Backbone cables (riser)
2) Horizontal (antenna) distribution cables
3) Provide sample reports showing the proposed format for cable test reports.
4) Provide a construction schedule showing the various work tasks, time periods, duration and staffing requirements.

C. Product Data: For each type of product indicated.
1. For coaxial and fiber optic cable, include the following installation data for each type used:
a. Nominal Optical Density (OD) (if applicable).
b. Minimum bending radius.

c. Maximum pulling tension.

D. The Contractor agrees:
1. Submittals and shop drawings processed by the Architect or Owner are not change orders.
2. The purpose of submittals and shop drawings by the Contractor is to demonstrate to the Engineer that the Contractor understands the design concept.
3. Submittals demonstrate equipment and material Contractor intends to furnish and install and indicate detailing fabrication and installation methods Contractor intends to use.
4. To accept all responsibility for assuring that all materials furnished under this Specification meet, in full, all requirements of the contract documents.

E. The Engineer's review is only for general conformance with the design concept of the project and general compliance with the information given in the contract documents. Corrections or comments made during this review do not relieve contractor from compliance with the requirements of the drawings and specifications. Contractor is responsible for:
1. Dimensions which shall be confirmed and correlated at the job site.
2. Fabrication process and techniques of construction.
3. Coordination of his work with that of all other trades.
4. Performing his work in a safe and satisfactory manner.
5. All Manufacturers' Instructions (including cable installation instructions)

PART 2 - MATERIALS

2.1 EQUIPMENT MANUFACTURERS

A. All equipment shall be the product of a manufacturer that has been in the business of manufacturing like product and financially stable for a period of at least five years. The bidder shall provide equipment references as required in the request for proposals

B. The Bidder shall commit, in writing, to factory support for the primary components of the DAS system, providing hardware availability and support for a minimum period of ten years following system implementation.

2.2 PARTS AND EQUIPMENT SPECIFICATIONS

A. Bidder shall provide parts and equipment list, and specifications for all components of the system, including, but not limited to:
1. Shielded Coaxial Cable and connectors
2. Fiber Optic cable and connectors
3. Optical and coaxial splitters and terminators
4. Interior Antennas
5. Donor antennas
6. Splitter/Taps/Couplers for the DAS
7. Radios, amplifiers, head end equipment, combiners
8. Combining equipment at the Head End

2.3 SPARE MATERIALS

A. Furnish spare materials described below, before installation begins, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Provide not less than one of each item listed below. Deliver extra materials to Owner.
   1. Antennas: One of each type installed.
   2. Active modules: One of each type installed.
   3. Passive Components (taps, combiners, splitters, couplers, etc.): One of each type installed.
   4. Cable: 100 feet (30 m); each type used
   5. Jumper Cables: Two for every type installed.

PART 3 - EXECUTION

3.1 COORDINATION

A. Design coordination is required for this Work. Coordination with General Contractor and the design team is required to address system integration and structure cabling design. Initial coordination meetings will be setup by the General Contractor and Owner.

B. Coordinate Work of this Section with on-site General Contractor and their sub-contractors. Initial coordination meetings will be setup by the General Contractor and Owner.

C. Coordinate layout and installation of distributed antenna system equipment and antenna cable with other construction that penetrates ceilings or is supported by them, including but not limited to light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

D. Coordinate location of cabling and antennas with other trades.

E. Coordinate location of equipment in the comm. rooms and spaces with the design team, Owner and the cable contractor.

F. Coordinate installation and system level measurement with design team, head-end electronics vendors and installation contractors.

G. Coordinate with the local public safety jurisdiction and secure "Approval to Carry" letter from the owner of each public safety radio system carried by the DAS. If multiple systems are covered, approval from each carrier is required.

H. Coordinate and verify with wireless carriers on the project specific electrical branch circuit requirements and power connection requirement (hard-wired or NEMA receptacle/plug type) based upon the wireless carriers' project specific equipment requirements. Also coordinate these requirements with the electrical contractor of this project.

I. Coordinate work of this Section with the requirements of each wireless service carrier. (early coordination has been attempted, please review Attachment B)

3.2 CABLE INSTALLATION

A. When possible, fiber optic cables, coaxial cable, and other associated cable and wiring shall be installed along the side of existing cable trays, in conduits, or attached to walls and ceiling.

B. Coaxial cables are to be terminated at bulkheads in each designated equipment room. Provide proper grounding on each bulkhead.

C. All cabling and antennas installed shall avoid damage to any post-tensioned decks and beams.

D. All installed cable shall be labeled "DISTRIBUTED ANTENNA SYSTEM CABLE" every twenty feet.

E. Contractor will provide as-built documentation of the installed cable system to owner and design team.

3.3 TESTING

A. Bidder shall provide detailed documentation specifying test procedures for installed cabling, antennas, radios, amplifiers, coverage, and management system.

B. Acceptance Testing Procedure
1. Upon completion of system, test to ensure that two-way communications coverage on each floor of the building meets the specified performance requirements. Each floor of the building shall be divided into a grid of approximately 20 equal areas.
2. Signal level measurements shall be made at two locations within each grid using a standard dipole antenna tuned a maximum of two nonadjacent areas will be allowed to fail the test by not meeting the minimum signal levels established.
3. In the event that three of the grids fail the test, in order to be more statistically accurate, the floor may be divided into 40 equal areas. In such an event, a maximum of two nonadjacent areas will be allowed to fail the test. After the 40 grid test, if the system continues to fail, the vendor shall alter the system to meet the coverage requirement.
4. Testing of stairwells and non-enclosed areas shall be performed as separate tests with statistics gathered separately for signal levels in the primary structure and parking areas. Signal levels shall meet the requirements for all areas enclosed by the structure and statistical methods shall not be used to dilute the intent of the coverage requirements.

C. Bidder shall perform cable testing for all install cables for the DAS.
1. FDR testing for the horizontal and vertical coaxial cables
2. OTDR testing for any fiber optic cables.

D. Provide copies of test results to General contractor

3.4 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced Installer who has completed installation of distributed antenna systems similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance. Bidder or installer will provide documentation indicating this prior experience.

END OF SECTION 272500

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Audio and Video Systems, Equipment and Infrastructure for the concert hall, band, choir and music tech rooms on the AV series of drawings.

B. Furnish and install fiber and copper cabling, cable terminations, equipment racks and custom interconnection plates. This includes all copper and fiber cabling throughout the AV series drawings.

C. Furnish and install audio and video presentation systems, production intercom systems, back of house sound systems and video monitoring systems. Furnish and install all interconnecting cables between related pieces of equipment and custom interconnection plates.

1. Concert Hall
2. Band Room
3. Choir Room
4. Music Lab Room

1.2 RELATED Sections

A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 - General Requirements sections, apply to the work specified in this Section.

B. Refer to Architectural, Electrical, and AV drawings for details.

C. Division 01 and Division 26 00 00 Specification sections apply to this section.

1. Section 260519: Electrical Power Conductors and Cables
2. Section 260526: Grounding and Bonding for Electrical Systems
3. Section 260533: Raceway and Boxes for Electrical Systems

1.3 COORDINATION

A. Project coordination shall be as described in Section 013000 – Administrative Requirements.

B. Project meetings shall be as described in Section 013000 – Administrative Requirements.

C. The installing division 26 Contractor shall verify all runs and size according to manufacturer’s recommendations, current edition of the NEC, inclusive of the State of Washington amendments, and the project general conditions and provisions for means, methods and materials as specified by the registered project electrical engineer. Where conflicts arise between contract documents, code requirements and manufacturer recommendations, contractor shall install the larger (higher capacity) item.

1.4 PRECONSTRUCTION EVALUATION

A. Verify All Conditions at Jobsite. Promptly report variations and obstructions to the AV Consultant. All additions or corrections are to be requested prior to fabrication.

B. Field measurements shall be taken by the AV Specialty Contractor prior to preparation of shop drawings to ensure proper fitting of work. Allow for adjustments during installation whenever taking field measurements.

C. Power shall be provided as directed on the contract documents. Should additional power or changes to the scope be required it will be the responsibility of the AV Specialty Contractor to notify the owner in a timely manner.

1.5 SUBMITTALS

A. Comply with Division 01 and Section 013000, unless otherwise indicated.

1. Complete schedule of submittals.
2. Equipment submittals as called out in Section 274116 Part 1, 1.05“B” below.
3. Chronological schedule: of Work in bar chart form (using Microsoft Project or similar program). Revise and resubmit schedule as required to reflect construction progress.

B. Product Data Sheets:

1. Submit a list of products (with manufacturer’s data sheets) on products to be incorporated within the Work. Arrange data sheets in specification order, per project system.
2. Submit bound originals of manufacturers’ product technical data for each product in sufficient detail to facilitate proper evaluation of product suitability for incorporation in the Work. Refer to Section 013000 for quantity of submittals.
3. Submit tab dividers for each group of data sheets. Arrange data sheets in specification order per system.

C. Shop Drawings:

1. Submitted simultaneously thirty (30) days after issuance of Notice to Proceed.
2. Shop drawings are to be prepared in the current version of AutoCAD. Subsequent revisions and Project Record Drawings are also to be generated in the current version of AutoCAD (2019LT).
3. Special details depicting methods and means specific to each product, assembly and each product manufacturer’s recommended installation methods and means.
4. Schematic: Detailed, redrawn wiring diagrams for each system, including cable types, identification and color codes, and detailed wiring of connections and terminal strips.
5. Floor Plans drawn to scale of not less than 1/8” = 1’-0”. Show AV Systems devices including wall and ceiling mounted speakers, wall and floor panels/plates, junction boxes, and terminal strip locations.
6. Detailed control wiring diagrams including pin-outs and component lists Include color codes and cable types.
7. Location of equipment in racks, consoles, tables, or cabinets, with dimensions. Wire routing and cabling within housings, AC power and terminal strip locations.
8. Custom Enclosure or Millwork: Full fabrication details indicating size, material, finish, and openings for equipment.

9. Mounting Details: **Retain services of registered professional structural engineer, licensed to practice in the State of Washington to review and develop mounting details for any device over thirty (30) pounds or 15' above the finished floor.** Structural information to include design calculations and copy of engineer's certification stamp. Location, orientation, and support systems shall be shown.
10. Labeling: Include representative equipment and cabling labeling scheme.
11. Include any other pertinent information generated which is necessary to provide the Work.
12. Develop a test report form to be used during the Testing Procedures described in Part 3. Submit this form for approval as part of the submittal package 30 days after notice to proceed.

D. Submit three bound original sets of the following Project Record Manual information after substantial completion and prior to final inspection.

1. On the cover of the bound original provide the project name, year and month of substantial completion, name of contractor, address of contractor, phone number for obtaining service in the event of failure and the official end date of the system warranty.
2. Product Data: Product actually incorporated within the work, including manufacturers' data sheet and owner's manual for each product. Include a complete list of all equipment with serial numbers of all products.
3. Record Drawings: Final rendition of drawings depicting the actual installed system.
4. Test Reports, as described in the test section and approved in the submittal process.
5. System Operation and Instructions: Prepare a complete and typical procedure for the operation of the equipment as a system, organized by subsystem or activity.
6. Service and Maintenance Manual: Provide and original copy of the service manual on every piece of equipment for which the manufacturer offers such a manual. Include phone numbers and hours of operation for all manufacturers.
7. Warranty Manual: Include manufacturer's warranty statements, date of substantial completion and ending dates for warranties for each type of product, plus any other pertinent data required for future maintenance.

1.6 QUALITY ASSURANCE

A. AV Specialty Contractor must be experience in the installation, servicing, programming and operation of fiber and broadcast systems with similar complexity as those shown on the contract documents. The AV Specialty contractor must have at least five years experience with the equipment and systems specified. Contractor must be capable of documenting relevant experience with projects of similar scope installed in the last five years.

B. Bidding contractors not listed above must furnish the following:

1. List of not less than five (5) projects of similar scope and size completed in the last five years indicating project value, project personnel, project owner and contact information.
2. Contractor shall furnish a list of project personnel, title, resume, to be used for project management, engineering and integration on this project.
3. The AV Specialty Contractor must be a franchised dealer and authorized service center for the major products specified ***(or provide acceptable documentation as to how products will be acquired and serviced)***.

1.7 REFERENCE STANDARDS:

A. Sound System Engineering: Don Davis, Eugene Patronis, Jr.

B. Audiovisual Best Practices: The Design and Integration Process for the AV and Construction Industries. Timothy W. and Jim Smith 2005

C. NFPA70 National Electric Code 2017 or current

D. NFPA 72 national Fire Alarm and Signaling Code 2016 or current.

1.8 NOMENCLATURE

A. The system shall be called the “audiovideo system”, and the installer the “AV Specialty Contractor”, or “AV Contractor”.

B. Drawing Series:

1. AV – AV Drawings – Concert Hall

1.9 WARRANTY

A. In addition to manufacturers’ warranties, the AV Specialty Contractor shall warrant all equipment to be free of defects in materials and workmanship for not less than one year after date of Substantial Completion. Defects occurring in labor or materials within the warranty period shall be rectified by replacement or repair within 72 hours (if parts require longer periods to obtain, provide substitute equipment during the intervening period). Response to service calls and requests for information shall be within 72 hours.

B. AV Specialty Contractor to furnish Owner with exact beginning and ending dates of the warranty period, include the name and phone of the contact person as well as the procedure for obtaining service.

C. Preventive Maintenance: At six months after system acceptance, and 30 days prior to the end of the warranty, provide a complete checkout of system components. Repair or replace defective equipment and correct any wiring or functional problems reported by the Owner.

PART 2 - PRODUCTS

2.1 Acceptable manufacturers

A. Wireless Microphone: Shure

B. Digital Audio Mixer: Soundcraft

C. Audio Processing: Symetrix

D. Assistive Listening Systems: Listen Tech, William Sound

E. Audio Amplifiers: Bose, Crown Audio, NEXO

F. Speaker Systems: Bose, JBL, NEXO

G. Control Systems: Crestron, Extron

H. Video Distribution: Crestron, Extron

I. Video Projection: Digital Projection, Panasonic

J. Video Projection Screens: Da-Lite, Draper,

K. Power Sequencing: Juice Goose

L. Equipment Rack: Lowell MFG, Middle Atlantic

2.2 EQUIPMENT:

A. Concert Hall:

1. Wired Microphones: Shure Beta 58a handheld vocal microphone. Provide two. Audio Technica AE5100 Instrument microphone. Provide Four. AKG C314 matched pair of multi-pattern condenser microphones. Provide one pair. Provide with 12 K & M 210 boom microphone stands and microphone cables.
2. Choir Microphones: Audio Technica ES933WC hanging choir microphone. Provide six with power supplies. Provide twelve input plate locations.
3. House Microphone: AKG PZM30D house microphone. Mount on bottom of middle catwalk. Route signal to Symetrix Audio DSP mixer.
4. Stage Managers Microphone: Astatic 651 handheld CB style microphone with XLR connection. Provide one. Located in the control room.
5. Audio Input Panels: Provide with ProCo Sound; microphone, audio line, data input panel with microphones inputs, monitor speaker outputs and RJ45 data port per plate. Provide as shown on plan.
6. Stage Floor Boxes: ETC Connect presentation stage floor boxes. Provide eight. Mount video transmitter and microphone input plates in floor boxes.
7. Digital Video Transmitters: Crestron DM-TX-200-C-2G-B-T Multiformat video input plate. Provide two with power injectors.
8. Wireless Microphones: Shure QLX-D wireless microphone transmitter receiver system. Provide six QLXD24/B58 handheld systems, one headset system and one podium gooseneck system with rack mount hardware. Provide with rack mount hardware and antenna combining systems. Provide plates at rear of concert hall for paddle antennae to mount in the house. Provide with Road Ready 14 space equipment rack on casters with locking front and rear covers. Provide with rack drawers.
9. Active Microphone Splitter: ProCo Sound MS42A active microphone splitter with three-way split. Route presentation microphones through splitter to DSP device and to digital audio mixer.
10. Source Players: Denon DN500CB CD player / blue tooth receiver player / aux input device. Provide one.
11. Assistive Listening Systems: Listen Tech LT800-72 transmitter, LR4200-72 receivers provide based on quantity of seats and ADA requirement. Provide with earbuds, rechargeable batteries, and ear cushions. Provide one signage plaque. Provide one LA381-01 batter charger.
12. Digital Audio Mixer: Soundcraft Performer 3, 32 channel digital audio mixer. Provide with MADI interface card. Provide with Souncraft MSB-16i stage box with MADI interface in portable rack. Provide with Apple iPad 12.9” 256 gigabyte tablet computer for use with audio mixing console. Provide Soundcraft MSB32R stage box at the amplifier rack.
13. Audio mixing / DSP Systems: Symetrix Solus NX 16 in 8 out audio mixer / equalizer. Provide with Netgear GS305P network switch with PoE.

14. Audio Amplifiers: NEXO NXAMP4X4 main speaker 4 channel audio amplifiers. Provide three. Crown Audio DCi 4/1250 Monitor speaker 4 channel audio amplifier. Provide two. Crown Audio DCi 2/300 back of house 70 amplifier. Provide one.
15. Main Speaker Systems: NEXO GEO M1012i (Install Version) line array system with two MSUB15i sub woofers. Provide two arrays. Provide with array hardware.
16. Monitor Speakers: JBL Professional PRX412m passive monitor speaker. Provide six with Neutrix SpeakOn 25' speaker cables.
17. Back of House Speakers: JBL Pro Control 26CT flush mount ceiling speaker. Provide quantity as shown on plans.
18. Volume Control: Lowell 100LVC-DW 100 watt volume control.
19. Power Sequencing Equipment: Juice Goose CQPD1-4 20 amp relay controlled power strip. Provide one. Juice Goose CQ-3000 30 amp relay controlled power outlet. Provide three. Juice Goose CQ1520 Rack Mount Power Center. Provide one. Juice Goose JG8.0 Rack Mount power center. Provide two.
20. Equipment Racks: Lowell MFG LER4027 40 space 27" deep equipment rack. Provide with locking front and rear doors, one 3RU rack drawer, rear rack rails, caster base, fan top, lacing bars, rack blanks and vent blanks. Provide one. Middle Atlantic RK8 desktop rack for portable equipment rack for source players at sound booth location. Provide two.
21. Wireless Production Intercom System: Provide stations as shown on plans. Clear Com FSII-Base-II wireless main station. Provide one. Provide with FSII-BP24X4 belt pack systems with Clear Com CC300 single muff headsets and BAT60 batteries. Provide two. Clear Com FSII-TCVR-24 transceiver antenna system. Provide one. Clear Com AC60 battery charger. Provide one.
22. Wired Production Intercom Equipment: Clear Com WP2 Belt pack wall panel. Provide quantity as shown on the plans. Clear Com IC-25 belt pack cables. Provide six. Clear Com HB702 headset wall station. Provide quantity as shown on plans. Clear Com KB701 single channel wall speaker station. Provide quantity as shown on plans. Provide quantity as shown on plans. Clear Com HS6 Handset with HB-702 wall station for House Manger. Provide one with recessed mounting enclosure. Clear Com RS701 single channel belt pack. Provide three. Clear Com PS702 power supply. Provide one. Clear Com CC300 headset. Provide a total of six.
23. PTZ Video Camera: Sony SRG300SE pan tilt zoom robotic video camera. Provide with Vaddio 535-200-243 wall mount plate and Black Magic Design HDMI to SDI transcoder. Route to video matrix and to HDMI to SDI transcoder.
24. Source Players: Denon DN500BD MKII blue ray DVD Player. Provide one.
25. Digital Video Switching Matrix: Crestron DMPS3-4K-150-C Audio video switching scaling matrix with twisted pair input and output ports, provide one. Provide with CEN-IO-RY-104 four port ethernet controlled relay box.
26. HDMI Distribution System: Crestron HD-DA8-4KZ-E 4k eight port HDMI Distribution Amplifier. Provide one. Crestron DM-TX-201-C TX 100-meter twisted pair HDMI transmitter for band, back of house corridor and video projector display devices. Provide two. Crestron HD-TX-101-C-E 40-meter twisted pair HDMI transmitter for lobby displays. Provide four.
27. LCD concert hall monitor: Owner Furnished Equipment. Provide with Chief LSMU wall mount bracket. Provide with four Crestron HD-RX-101-C-E HDMI receivers for lobby displays. Provide with two DM-RMC-4KZ-100-C HDMI receivers for band and back of house corridor displays.
28. Video Projection Systems: Panasonic PT-RZ970 WUXGA 1920 x 1200 single DLP video projector. Provide with long throw lens. Mount on custom shelf above ceiling in control room at back of house. Provide with Crestron DM-RMC-4KZ-100-C HDMI receiver. Connect control to projector through HDMI receiver.

29. Video Projection Screens: Draper Premier XL 108" x 192" projection screen with Matt White XT1000VB surface material. Provide with low voltage control interface. Provide with 24" of drop. Mount to wall above the upstage cloud to hide case from view.
30. Stage Managers Control Panel: Crestron TSW-760-B-S 7" control touch panel. Mount above stage managers panel adjacent to HB702 Headset intercom station. Power via POE network switch.
31. Sound Booth Control Panel: Crestron TSW-760-B-S 7" touch panel control for tabletop operation. Provide with Crestron TSW-760-TTK-B-S tabletop kit. Power via POE network switch.

B. Band / Choir Rooms:

1. Wired Microphones: Shure Beta 58 handheld vocal microphone. Provide two. Audio Technica AE2500 Dual diagram bass instrument microphone. Provide one: Audio Technica AE5100 Instrument microphone. Provide two. Provide with four K & M 252 microphone stands with boom arm adapter and microphone cables.
2. Choir Microphones: Audio Technica ES933WC hanging choir microphone. Provide four with power supplies in Band & Choir Room.
3. Audio Input / Output Panel: ProCo Sound microphone, audio line, data input output panel. Provide as shown on plan.
4. Stage Floor Boxes: ETC Connect presentation stage floor boxes. Provide two per room. Mount video transmitter and microphone input plates in floor boxes.
5. Wireless Microphones: Shure QLX-D wireless headset microphone transmitter receiver systems. Provide one.
6. Source Players: Denon DN500CB CD player / blue tooth receiver player / aux input device. Provide one.
7. Audio Mixer: Soundcraft Si Impact digital audio mixer with integrated effects and USB recording capabilities.
8. Audio Equalizer DSP: Extron DMP 44 LC four channel audio digital signal processor. Provide one.
9. Main Speakers: Yamaha DXR10 powered two-way main speaker. Provide two. Provide with SMS-75-ASB mounting array hardware.
10. Equipment Racks: Lowell MFG LPR-1427PGT 14 space equipment rack with laminate top. Provide with locking front and rear doors, rear rack rails, lacing bars, rack blanks and vent blanks.
11. Source Players: Denon DN500BD MKII blue ray DVD Player. Provide one.
12. Digital Video Switching Matrix: Crestron HD MD6x2 rack mount matrix switcher. Provide one. Provide with Crestron DMPS Lite HDMI extender pairs as shown on the AV Sheets.
13. Video Display Mount: Peerless-AV ST680P wall mount tilting display for up to 98" displays. The display is provided by owner and installed by the AV Contractor.

C. Music Lab:

1. Wired Microphones: Shure Beta 58 handheld vocal microphone. Provide four. Provide four K & M 252 mic stands with boom arm adapter and microphone cables.
2. Choir Microphones: Audio Technica ES933WC hanging choir microphone. Provide two with power supplies.
3. Audio Input / Output Panel Grid Interface Panel: ProCo Sound microphone, audio line, data input output panel. Provide as shown on plan.
4. Stage Floor Boxes: ETC Connect presentation stage floor boxes. Provide six. Mount video transmitter and microphone input plates in floor boxes.
5. Wireless Microphones: Shure QLX-D wireless headset microphone transmitter receiver system. Provide one.

6. Source Players: Denon DN500CB CD player / blue tooth receiver player / aux input device. Provide one.
7. Audio Mixer: Soundcraft Si Impact digital audio mixer with integrated effects and USB recording capabilities.
8. Audio Equalizer DSP: Extron DMP 44 LC four channel audio digital signal processor. Provide one.
9. Main Speakers: Yamaha DXR10 powered two-way main speaker. Provide with light source 2" lighting grid mounting clamps. Provide two each.
10. Equipment Racks: Lowell MFG LPR-1427PGT 14 space equipment rack with laminate top. Provide with locking front and rear doors, rear rack rails, lacing bars, rack blanks and vent blanks.
11. Source Players: Denon DN500BD MKII blue ray DVD Player. Provide one.
12. Digital Video Switching Matrix: Crestron HD MD6x2 rack mount matrix switcher. Provide one. Provide with Crestron DMPS Lite HDMI extender pairs as shown on the AV Sheets.
13. Video Display Mount: Peerless-AV ST680P wall mount tilting display for up to 98" displays. The displays are provided by the owner and installed by the AV Contractor.

2.3 SOURCE QUALIFICATIONS

A. Model numbers and manufacturers included in this specification are listed as a standard of quality. Other qualified manufacturer's products will be considered subject to submission and approval of complete technical data, samples and results of laboratory tests, in accordance with Section 016000. Substitutions will only be accepted if, in the opinion of the AV Consultant, the product is an equal to the specified product. No substitutions may be made without written acceptance from the AV Consultant. All substitutions made prior to this acceptance are at the sole risk of the AV Contractor. Substitution requests need to be submitted no less that (10) ten business days prior to the bid date.

B. Specific equipment for each system is listed on the construction drawings and in this specification. The specification and drawings are representative of the design and do not necessarily provide all hardware, miscellaneous equipment, software and details for a fully functioning system. It is the responsibility of the AV Specialty Contractor to ensure the system is complete and functions according to the system descriptions and design intent.

C. For bids to be considered complete and qualified they must be bid per the documents and specifications. If the proposed system includes equipment other than that specified, submit a list of major items and quantities, with a one-line schematic diagram in addition to the bid for review and approval. Include a list of previously installed projects with similar equipment included. This list is to be submitted as an alternate to the actual bid document.

2.4 GENERAL

A. Provide new equipment and materials which conform to applicable UL, SCA, or ANSI provisions.

B. Regardless of the length or completeness of the product description in this specification, each device shall meet the published manufacturer's specifications. Verify performance as required.

C. Cable and Wire: The highest quality, lowest signal degradation cable and wire shall be used for the project. Shown below are typical cable and wire types. AV Specialty Contractor shall submit wire and cable types for approval prior to wire pull.

1. Line Level Audio: Belden 9451
2. Control: Belden 9455 (9 conductor control cable),
3. Belden 9451 serial data cable and serial IR cable,
4. Belden 1583A Data/Ethernet cable.
5. Video: Belden 7789A (5 coax VGA cable),
6. Belden 1694A RG-6 Coaxial cable
7. Belden 1808A S-video cable,
8. Mohawk M58283 or Belden 1874A Video over category 6 twisted pair cable
9. Speaker Level Audio (over 100'): West Penn C210
10. Speaker Level Audio (under 100') West Penn 227
11. Speaker Level Audio (70 Volt) West Penn 225

2.5 COMPONENTS

A. Assembly/Fabrication:

1. Coordinate work with other trades to avoid causing delays in construction schedule
2. Mount equipment and enclosures plumb and square. Permanently installed equipment to be firmly and safely held in place, with equipment supports having safety factor of 5 for mounts and 3 for all other equipment
3. Cover edges of cable pass-through holes in chassis, racks, boxes, etc, with rubber grommets or Brady GRNY nylon grommet material.
4. System Wiring: Take precautions to prevent and guard against electromagnetic and electrostatic interference (hum and buzz). Check AC power and grounding prior to system installation and report any issues promptly.
5. Equipment and Cable Labeling: Provide engraved lamicoid labels on front and rear of active equipment mounted in racks. Include name of device, reference to drawing name, and other areas the device feeds or controls. Label cables in a consistent manner, with permanent, heat-shrunk labels. Show all equipment designations in Permanent Record Drawings.
6. Conduit: All cable and wire shall be run through EMT conduit or as specified on the contract documents. Separate conduits shall be used for video, line-level and microphone level audio, control, amplified audio to speakers, and network signals.
7. All equipment and components shall be new and complete. No used or reconditioned equipment shall be acceptable.
8. All mounting hardware shall be included.
9. All equipment and components shall be factory tested prior to shipping.
10. All bolts and fasteners must be Grade 5 or better.
11. All bolted attachments to have lock washers or other approved self-locking hardware.
12. All microprocessor controls shall utilize a non-volatile memory. System configuration, operating parameters, presets, etc. shall be protected against system power failure for a minimum of 1 hour.
13. All internal rack wiring shall be completed at the AV Specialty Contractors office and clearly marked. All field connections shall be by connector, terminal strip or other device previously specified. Any terminal strip connections shall be clearly labeled as to terminal designation.
14. All wire sizes and insulation to comply with UL standards and local codes.
15. All wiring to be harnessed and bound. No loose or randomly routed wires shall be permitted.
16. Any supplementary or auxiliary equipment necessary for the operation of the system shall be supplied with overload and short-circuit protection.

17. Do not purchase or fabricate any materials, components or items to be used in the video and distribution systems prior to review of shop drawings, unless otherwise directed by AV Consultant.
18. Use only materials, components and items that conform with industry practice and applicable code standards. Use only components which are new and never previously used. Take care during installation to prevent scratches, dents, chips, etc.
19. Install all rack-mounted equipment with 10-32 button head machine screws with Phillips head.
20. Custom rack panels shall be 1/8" thick aluminum, standard EIA sizes, brushed black anodized finish unless otherwise noted. (Brush in direction of aluminum grain only.) Custom connector plates (loudspeaker, microphone, video, etc.) are typically stainless steel. It is the responsibility of the Contractor to verify plate finish with the AV Consultant. Plastic plates will not be accepted.
21. All engraving shall be 1/8" block unless noted otherwise. Except where noted to the contrary, on dark panels or pushbuttons, letters shall be white; on stainless steel or brushed natural aluminum plates, or light-colored pushbuttons, letters shall be black.
22. Connections shall be made with approved connectors and/or terminal blocks equal to Cinch 140 series or as indicated.
23. Per IEC-268 standard, all XLR connectors, within equipment or out, shall be wired pin 2 hot (high), pin 3 low, and pin 1 shield (Ground / Earth).
24. Unless otherwise stated, all rack-mounted electronic and electrical equipment and components shall conform to EIA 19" standard. Any devices not specifically designed to be rack mountable shall be adapted, by professionally acceptable methods, to meet the EIA standard.
25. All wire shall be harnessed, bound and routed neatly with no loose or randomly routed conductors.
26. All joints and connections shall be made with rosin-core solder or with mechanical connectors approved by the AV Consultant. Where spade lugs or other crimp-type terminals are used, crimp properly with ratchet type tool. Between racks, cabinets, consoles or modules, all cable shall terminate in approved terminal connectors, strips, blocks or boards.
27. Route unbroken video, audio line and control wiring from receptacle plate/chassis to rack. Remove spliced cables and replace without additional charge to Owner.
28. No splices shall exist in any length of wire run except where noted on drawings.
29. All terminations of shielded cables shall consist of a PVC or neoprene heat shrink sleeve covering the shield drain wire and an overall PVC or neoprene heat shrink sleeve covering the point at which the cable jacket and shield end.
30. Run vertical wiring inside rack in properly sized raceway with snap-on covers (Panduit type E series). Horizontal wiring in rack to be neatly tied in manageable bundles with cable lengths cut to minimize excess cable slack but still allow for service and testing. Provide horizontal support bars for cable bundle sag. Neatly bundle excess AC power cable from rack-mounted equipment with plastic cable ties. Rack wiring to be bundled with plastic cable ties or lacing twine. Electrical tape and adhesive-backed cable tie anchors are not acceptable.

B. AC Power and Grounding:

1. Coordinate final connection of power and ground wiring to racks. Review UPS systems to ensure power connection is suitable for specified UPS system.
2. Install approved isolated-ground receptacles in wire way in each rack. Provide a minimum of two spare outlets in each rack. Label each outlet as to which AC circuit is feeding it and provide the same information in the circuit breaker panel.

3. Ground equipment chassis not having a three-wire power cord to these busses. Connect green ground wire from each AC outlet in rack to this bus bar.
4. AC power for the AV Systems is distributed at 120 VAC, 60 Hz, on the same electrical phase, building wide.
5. Isolated-Ground (Audio Ground) Distribution:
6. All conduits and back boxes containing Audio, Video or Communication Systems wiring shall be permanently connected to the building electrical safety ground.
7. Note: RF video devices, being unbalanced in nature, shall not be connected to the sound system audio ground network. Care shall be taken when intermixing such video and audio equipment.

C. Electrical Safety:

1. No voltage in excess of 25V RMS AC or 24V ripple free DC shall be exposed to touch in normal use or in any equipment by the withdrawal of modules or of any plug or connector or without the removal of suitably indelibly labeled covers.
2. Unless specifically accepted, all live electrical parts above 50V RMS AC or 60V ripple free DC, including terminals, shall remain completely shrouded by insulation or grounded metal when the main access panels are removed. The separate shrouds or covers shall require a tool to remove them to prevent inadvertent contact with live parts.
3. In addition, where enclosures or items of equipment containing predominantly control, computer, or similar low voltage signals also contain voltages in excess of 50V RMS AC or 60V ripple free DC, clear standard warning notices indicating the maximum voltage present shall be provided on all removable access panels. Similar warning notices shall be provided where voltages exceeding 120V are present in any enclosure or item of equipment and such a voltage would not reasonably be expected to be present.
4. Within enclosures, racks and panels identify with prominent, standard, and indelible signage which circuit breakers or disconnects are to be switched off in order to isolate the equipment totally. Warning notices shall also be provided on all equipment which contains live terminals after operation of its circuit breaker or disconnect. These terminals must be completely shrouded to prevent inadvertent contact.
5. All equipment, control stations, equipment racks, enclosures, and all metal cases, raceways, and conduit shall be efficiently grounded. Special hand held or portable equipment which is not double insulated shall have duplicated grounding connections. All grounding shall be in accordance with the current edition of the National Electrical Code and as identified within this specification.

2.6 ACCEPTANCE

A. Acceptance testing will include operation of each major system and any other components deemed necessary. AV Specialty Contractor will assist in this testing and provide the test equipment specified herein. AV Specialty Contractor shall provide at least one technician available for the entire adjustment and testing period (day and night), to assist in tests, adjustments, and final modifications. All tools and material required in making any necessary repairs, corrections, or adjustments shall be provided by the AV Specialty Contractor.

B. The Owner will physically inspect the system to ensure all equipment is installed in a neat and professional manner and as required by the contract documents. An inventory will be made of all equipment.

C. Perform the following procedures on the System:

1. Adjust, balance, and align all equipment for optimum performance and to meet all manufacturers' published specifications. Settings to be reviewed include gain, delay times, and nominal settings. Establish and mark normal settings for all level controls and record these settings in the System Reference Manual.
2. Check all control functions for proper operation, from all controlling devices to all controlled devices.
3. Video Signal: From all source inputs (for cameras, character generators, video tape units, etc.) through all VDAs, processors, switchers, etc., to all signal destinations. Verification of correct signal timing for each source via each path will be made using standard test patterns. Each processing device will be checked; the signal shall pass through the device in the no processing mode such that unity luminance, chrominance, and signal timing and phasing conditions are achieved.
4. Any other test on any piece of equipment or system the Owner deems appropriate.

D. In the event the need for further adjustment or work becomes evident during acceptance testing, the Integrator will continue his work until the system is acceptable at no addition to the contract price. If approval is delayed because of defective equipment, or failure of equipment or installation to meet the requirements of these specifications, the Integrator will pay for additional time and expenses of the AV Consultant at the AV Consultant's standard rate in effect at that time, during any extension of the acceptance-testing period.

2.7 DELIVERY HANDLING AND STORAGE

A. Delivery: Deliver loose or unincorporated products in original unopened packaging with legible manufacturer's identification.

B. Storage and Protection: Comply with manufacturers recommendations. Store in a cool, dry place, out of direct sunlight, and protect from damage. Provide protective covering during installation to prevent damage from dust or other foreign materials. For products not currently installed provide secure locked storage both on site and at the AV Specialty Contractor's own facility.

PART 3 - EXECUTION

3.1 INSTALLERS

A. The AV Specialty Contractor must be experienced in installation of systems with similar complexity as those required for this project. They must have at least five years experience with the equipment and systems specified and must be able to document relevant experience with projects of similar scope installed within the past five years.

B. Installers Qualifications:

1. Provide proof of bonding capacity for an amount equal to this project as required by the general conditions.
2. The AV Specialty Contractor must be a franchised dealer and authorized service center for the major products specified (or provide acceptable documentation as to how products will be acquired and serviced).
3. Installation technicians shall be CTS I certified. CTS I certification indicates that the technician installs and maintains audiovisual systems by following specifications, schematics, codes and safety protocols.

3.2 EQUIPMENT RACKS AND ENCLOSURES

A. Space shall be provided for video equipment in the sound system rack provided under separate section of the construction documents.

B. Provide matching 1 U ventilation panels above and below all video switching and processing equipment.

C. Provide one (1) rack mount AC power receptacle strip for each rack group, with a minimum of one (1) 120V 20A duplex receptacle (NEMA 5-20R) for each individual rack (e.g., a group of three (3) racks requires a total of three (3) duplex receptacles). Receptacle strip shall mount to the front of one rack and be connected to an unswitched AC power circuit.

D. All metal cabinets connected to the AC ground shall be effectively isolated from any conduit or other metallic component that is connected to the building electrical safety ground.

3.3 BACK BOXES (SIZES AS SHOWN ON DRAWINGS AND SCHEDULES):

A. All rough in boxes shall be flush type for mounting in the wall, floor or ceiling recess.

B. Trim devices: Standard gang (size to match rough in detail drawings), type 302 stainless steel (heavy gauge) bright brushed or satin finish. Mount panels to back box with 6-32 stainless steel, slot or Phillips drive, oval head machine screws.

C. Standard dimensional electrical J-boxes, flush-type electrical enclosure. Mount panels to back box with 8-32 stainless steel, slot or Phillips drive, oval head machine screws.

D. Plates in public areas to have finish by Architect.

E. Back Box: Provided under Div 26, Hoffman type with a minimum depth of 4". Color: Black. Exceptions as noted below. Coordinate with Electrical Contractor.

3.4 AV Receptacle Panels

A. AV Panels (Sizes As Shown On Drawings And Schedules): Fabricated of type 5052-H32 aluminum, 0.125" minimum thickness, lightly brushed (vertical direction), with black anodized and clear sealed finish. Panel dimensions to match back box size. Edges of panel shall be ground square and flat. Comers of panel to have small radius. Exceptions as noted below.

B. Custom Fabrication: Single or multiple signal level and circuit receptacle panels for connection of concert hall sound systems devices at designated locations in the facility. Panels may include any combination of circuits and connectors for these signal levels: microphone level, line level, video level, intercom level, and low volt/impedance loudspeaker level. Connectors shall be identified as to signal level, circuit type, and circuit number by clearly engraved and coordinated legends on each panel. Exceptions as noted. Refer to device plans for locations.

C. Refer to Systems Panel & Device Schedule (Electrical Drawings) for back box type, size, and depth, and mounting information.

D. AV panel covers shall be furnished and installed by the AV Specialty Contractor, except as noted.

E. Wire shall be supplied, pulled, and terminated by the AV Specialty Contractor

F. Connector: Panel or chassis types, as indicated below. Mount on AV Panel as shown on drawings and fasten with stainless steel machine screws, hex nuts, and lock washers (screw head style, color, and thread size to match connector body; slot or Phillips drive to match wall plate screws). Refer to connector specification paragraph below. Exceptions as noted.

1. Line level (NL" series Neutrik): Male & female XLR-3 pairs.
2. Production video coax ("V" series ADC): Female BNC.
3. Modulated Video ("CV" series F-Conn): Female F-type
4. Video over Twisted Pair (RJ45 CAT 5 termination).
5. Speaker (Speakon Series Neutrik): Male & female 4 or 8 pin.

G. Engraved Legend: Details as indicated below. Locate legends on AV Panel as shown on drawings. Characters shall be engraved, filled with colored enamel, and entire panel sealed. Exceptions as noted.

H. Legends shown on drawings are typical. Refer to Video Systems block diagrams and/or submit proposed layout to Consultant for review.

I. Signal level title legend size shall be 0.1875" or 0.250" high characters of medium weight (as required).

3.5 Termination:

A. BNC-type Connector: Attach double crimp-type (crimp-crimp) straight plug to end of coaxial cable for connection directly to the feed-through jack. Ensure integrity of coaxial cable shield isolation from back box by insulating connectors (and/or any adapters) with a shroud or hood of shrink tubing, or similar material. Plastic "electrical" tape is not acceptable.

B. F-type Connector: Attach double crimp-type (crimp-crimp) straight plug to end of coaxial cable for connection directly to the feed-through jack. Ensure integrity of coaxial cable shield isolation from back box by insulating connectors (and/or any adapters) with a shroud or hood of shrink tubing, or similar material. Plastic "electrical" tape is not acceptable.

3.6 SITE TESTS AND INSPECTIONS

A. Preliminary: Verify the following before beginning actual tests and adjustments on the system:

1. All electronic devices are properly grounded.
2. All powered devices have AC power from the proper circuit. Verify all dedicated AC power circuits are properly wired, phased, and grounded.
3. Insulation and shrink tubing are present where required.
4. Dust, debris, solder splatter, etc. is removed.
5. All cable is dressed, routed, and labeled; all connections are properly made and consistent with regard to polarity.

3.7 INSTRUCTION OF OWNER PERSONNEL

A. Provide four (4), four (4) hour instruction sessions to the Owner’s designated personnel on the use and operation of each of the systems as described in section 274116 Part 1.01,C. The instructor must be fully knowledgeable of all system functions and all equipment features. The

System Reference Manuals shall be complete and on-site at the time of instruction. The AV Specialty Contractor shall be present at the first two formal uses of the system.

END OF SECTION 274116

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. The existing campus is a Rauland Telecenter 21. This system shall be maintained for the existing campus. For the new campus providel a new Rauland-Borg Telecenter U school intercommunication and clock system. It shall intergrate with the existing analog Rauland Borg Telecenter that serves the existing campus.
   1. All new speakers shall be IP speakers except in restrooms, hallways, and exterior which may be analog through an IP gateway as shown on the drawings.
   2. Base bid is standard 2.5” LCD clocks, 24 V class 2

1.2 SUMMARY

A. This section includes a fully operational IP platform for district-wide internal and school communications system incorporating school safety notifications and general communications including, but not limited to, the following:
   1. The platform shall provide complete internal communications and employ state of the art IP technology, including the minimum functions listed.
   2. Two-way internal intercommunications between staff locations and classrooms.
   3. Scheduled bell events.
   4. Emergency announcements will override any other system functions assuring that all Emergency/Lockdown, etc., are heard at every speaker location.
   5. Capability of prerecording emergency announcements that can simply be activated by a simple soft key, or via a dedicated push button.
   6. Atomic time synchronization with class change tones utilizing multiple programmable schedules for each zone.
   7. District-wide, emergency, group, all-school, and zone live voice paging.
   8. District-wide, emergency, group, all-school, and zone paging for pre-recorded audio-tones, music, and voice.
   9. Web-based user interface.
   10. The system shall support a minimum of 1000 level priorities which shall be user definable, allowing each end point to place a minimum of five different priority calls at the same time.
   11. Any authorized administrator shall be able to call from outside the school into any classroom, zone, or the entire school directly via the district-supplied SIP-enabled telephone network. This shall allow remote monitoring, call-in annunciation, and two-way conversation from outside the facility as well as paging into the system. (Compliance with NEMA Standard SB-40 for emergency communications in K-12 Schools.)
   12. Authorized system users shall be able to create a minimum of 20 automated sequences with emergency instructions, tones, emails and relay activations and replay them.
   13. Automated message strings shall be manually initiated from a single-button access on the console, on a SIP-connected telephone, from a panic button, from the web interface, or via interface with third party systems.
   14. Paging and two-way intercom features shall be accessible from any system console or SIP-connected telephone for each campus.
   15. The platform shall synchronize its system time to the network time server or a web-based time server.

16. Each single campus installation shall be locally survivable for intercom, paging, bells, and emergencies such as lockdown, even when the district connection is unavailable.
17. This specification establishes a minimum level of quality, features, and performance for individual components as well as the integrated system.

1.3 SUBMITTALS

A. Cut Sheets: Provide standard manufacturer's product cut sheets for each device being added to the system.
   1. The cut sheets shall include product dimensions, weight, and required clearances, and information for rough-in as required.

B. Shop Drawings: Provide drawings showing equipment rack riser, method of field assembly, components, and location of each field device.
   1. Wiring: Detail wiring requirements and provide supplemental instructions for cable runs.
   2. Each drawing shall have a descriptive title and all sub-parts of each drawing shall be labeled. All drawings shall have the project name and locations, and the systems contractor's name in the title block.
   3. Details and descriptions of any other aspect of the system, which must differ from the contract documents due to field conditions or equipment, furnished.

C. A copy of the manufacturer's standard statement of warranty proving all equipment provided for the school communications network is covered with the required five-year warranty shall be included with the project submittal. This statement of warranty shall be provided on the manufacturer's stationary.

1.4 QUALITY ASSURANCE

A. Contractor Qualifications: The intercom system extension shall be installed by skilled technicians all of whom are properly trained and certified by the manufacturer. This contract is limited to the following prequalified contractor: Electrocom of Lynnwood, Washington, 425-774-6600. Contact them prior to the bid to verify all requirements. Include all of their costs in the bid.

B. An experienced contractor who is an authorized representative of equipment manufacturer for both installation and maintenance of equipment required for this Section. Provide the following within 30 days after notification to proceed:
   1. Provide a list of installations that the contractor has specifically installed for verification by the owner. Random installations from other vendors and/or contractors shall not be accepted. The contractor, not its employees, must meet these qualifications.
   2. The contractor shall be bondable.
   3. The contractor shall demonstrate to the satisfaction of the owner or their representative that they have:
   4. Adequate plant and equipment to pursue the work properly and expeditiously.
   5. Adequate staff and technical experience to implement the work.
   6. Suitable financial status to meet the obligations of the work.
   7. Technically capable and factory trained service personnel at a local service facility to provide routine and emergency service for all products used in this project.

C. Any contractor, who intends to bid on this work and does not meet the requirements of the "Quality Assurance" paragraph(s), shall employ the services of a "contractor" who does meet

the requirements and who shall provide the equipment, make all connections and continuously supervise the installation. A subcontractor so employed as the "contractor" must be acceptable to the architect/engineer. The "contractor" shall be identified within 30 days of notification to proceed for acceptance by the architect/engineer.

D. Because the life expectancy of this type of communications structure normally exceeds ten years, the owner expects continuity from the service provider. If the installing/servicing company has not been an authorized provider of the manufacturers product for it least ten years, the following is required:
   1. A list of two systems manufacturers of which they currently are authorized service providers where the relationship exceeds ten years
   2. A letter from the manufacturer outlining the details of changes in service providers over the last ten years, and what actions they will take to ensure continuity of service to the customer.

E. Each major component of equipment shall have the manufacturer's name and model number located in a conspicuous place. If requested, contractor shall be able to provide NEMA code ratings, UL label, or other pertinent data related to the equipment.

1.5 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide the following system:
   1. Telecenter manufactured by the Rauland-Borg Corporation.
   2. Authorized Rauland-Borg Distributor Contact:

      Name: Electrocom
      Address: 6815 216th Street SW
      Lynnwood, Washington 98036
      425-774-6600
      Contact: Art Howard, extension 150 / Ben Swerk, extension 154
      Email: ArtH@electrocom.us / BSwerk@electrocom.us

PART 2 - PRODUCTS

2.1 SYSTEM REQUIREMENTS

A. Rauland Borg Telecenter U System shall include, but not be limited to, state of the art IP technology for call-in notification, school safety paging and evacuation tones, atomic time synchronization, class change tones utilizing multiple, programmable schedules for each zone, two-way hands-free internal intercommunications and paging, and program distribution. The system shall be easy to learn and operate. All standard programming shall be web based and user friendly to allow the system administrator the ability to easily program system features.

B. Provide complete and satisfactorily operating district/school communications and district/school safety as described herein, using materials and equipment of types, sizes, ratings, and performances as indicated. Use materials and equipment that comply with referenced standards and manufacturers' standard design and construction, in accordance with published product information. Coordinate the features of all materials and equipment so they form an integrated system, with components and interconnections matched for optimum performance of specified functions.

C. The platform shall be a single electronic system consisting of a minimum of 10 intercom channels for each campus, (classroom) IP speaker modules and call switches, IP zone modules connecting corridor speakers, inside and outside horns, IP administrative consoles, SIP-enabled PBX integration, and district-wide integration for paging, emergency notifications, calendar scheduling, and configuration.

D. Each classroom shall be provided with an IP speaker module interface and up to five different call-in switches, each with their own annunciation path and priority.

E. Call-ins may automatically annunciate (display of priority and location) to administrative consoles, SIP-enabled phones, and outside phones.

F. Call-ins shall be programmed to automatically change priority and annunciation route based on age of call-in and original priority.

G. Call-ins may have priority (and annunciation route) changed by user action from a console or SIP-enabled phone.

H. Call-in annunciation route shall include playing pre-recorded audio over speakers, sending a pre-configured email, and activating relays.

I. The platform shall lend itself to expansion by simple addition of hardware modules.

J. The platform shall directly connect to the WAN/LAN without the need for a separate server at each school location. Configuration, including bell schedules, calendars, and emergency sequences can remotely be created, changed, stored, and downloaded to the system by an authorized user from a browser-based interface.

K. The platform shall provide the ability to initiate school safety paging announcements, evacuation tones, and take cover tones from any telephone or connected web-browser within or outside the facility to any other location within the facility or district.

L. The platform shall provide the ability to selectively communicate or monitor individual classrooms in emergency situations from any telephone within or outside the facility to any other location within the facility; all communication within the classroom shall be hands-free, and will not require any interaction by the classroom user.

M. The platform shall provide classroom users the ability to confirm that they have safely secured their classrooms during lockdown with a single button press.

N. IP-addressable and POE powered speaker modules for individual rooms shall be system programmable, and may be assigned any two, three, four, five, or six digit number as well as name and description. Any extension may be reassigned at any time.

O. IP-enabled two-way voice communication shall be available from any provided telephone or administrative console through any speaker in a campus. This shall allow hands-free communication to any classroom or any individual loudspeaker unit. A programmable pre-announce tone shall sound immediately before the intercom path is opened, and a supervisory tone shall continue to sound at regular intervals when speaker monitoring is active, complying fully with all privacy legislation. Pre-announce tone and supervisory tones shall be disabled during designated emergencies automatically.

P. The platform shall allow users to configure multiple schedules per school, with a minimum of 500 unique events per schedule, and automatic Daylight Savings Time correction. A minimum of five schedules may be active on any given day for each campus. User shall be able to select from 25 standard included tones as well as unlimited user created and uploaded audio files for class change signaling and messaging. In addition scheduled events shall include relay actions, email notifications, paging exclusions as system configuration changes. The platform shall allow control of the bell schedules via the district WAN/LAN without the need for a separate server at each school location. Bell schedules can remotely be created, changed, stored, and assigned to calendar days for the local school by an authorized user from a browser-based interface.

2.2 EQUIPMENT AND MATERIAL

A. Server Software

1. The software shall provide district-wide paging, bell event scheduling, emergency notification, and configuration for entire district.
2. The software shall have the ability to configure and initiate system features, per school and district-wide via web based interface.
3. The software shall have the ability to sync system time to the atomic clock signal or to the school's or district's network time server
4. The software shall provide a web-browser to deliver district-wide emergency paging, pre-recorded messages and tones from any authorized computer in the facility or the district. The software must be capable of automatically notifying district personnel via the WAN of an alarm condition.
5. The software shall automatically broadcast page emergency instructions via associated system hardware throughout an entire district when an alarm (e.g. lockdown, lockout, security, fire) is initiated via the web-based interface. The emergency instructions are pre-programmed, and require no user intervention. The system shall provide redundant alarm annunciation over intercom/paging speakers, and is not meant to replace primary fire alarm or security systems.
6. The software shall have the ability to be installed in cloud, virtual, or physical server environments.
7. The web-based user interface shall support secure HTTP browsing.
8. The server software shall support encryption to ensure secure access.
9. The software shall support any combination of VoIP Telecenter Campus controllers and Telecenter page modules for a minimum of 1000 facilities.
10. The software shall support a minimum of 50,000 IP speaker modules, district-wide.
11. The software allows for user-uploaded pre-recorded messages and tones. Software supports the upload of MP3 and WAV file types. User-uploaded pre-recorded messages and tones can be part of emergencies, sequences, and bell schedules.
12. The system shall monitor itself if devices go offline and system actions are not received. Specified users shall receive email notifications when devices go offline. The software shall be able to keep a log and report on system activity within a school or all schools district-wide for a minimum of one year. These reports can be exported to excel spreadsheets.
13. The system allows programmable end points to be automatically included or excluded for live paging, bell tones, or prerecorded audio, depending on the time or day or day of the week. These inclusions/exclusions can be applied manually or automatically depending on their schedule.
14. The software can automatically send an email, as part of a programmed sequence of events, to district administrators alerting them of an emergency within the district.

15. The software provides the ability to view schools that are in an emergency status, using any web browser on the district's network. The software shall identify the name of the school in an emergency as well the type of emergency that school is in.
16. The system has a minimum of 5 customizable emergencies, one of them being an All-Clear – with the ability to return the system from an emergency to normal status. Each emergency shall have a minimum of 500 unique events.

B. Campus Controller
1. The campus controller shall provide call routing for paging and intercom for a single facility.
2. System shall connect to the district-provided Telephone Network via a SIP connection.
3. The system shall support a flexible numbering plan allowing two, three, four, five, or six digit extensions.
4. SIP interface to a district-provided Telephone Network shall be capable of allowing connected phones to display classroom call-ins, answer internal intercom call-ins, make pages, and change priorities of call-ins in progress.
5. The system shall provide direct dialing, two-way amplified voice intercom between any provided telephone, or admin console and speaker without the use of a press-to-talk or talk-listen switch.
6. The system shall have the ability to place two levels of call-in from any call-in switch.
7. The system shall have the ability to answer intercom call-ins registered at administrative consoles and pre-selected telephones.
8. The system shall have the ability to automatically escalate incoming call-ins to an alternate telephone or group of telephones if they remain unanswered for a predetermined amount of time.
9. The system shall have the ability to manually upgrade an intercom call-in to an alternate telephone or group of telephones.
10. The system shall have the ability for classrooms to "check-in" via push button when they have successfully secured their location during an emergency.
11. The administrative console shall display locations that have not checked in to confirm their secured location, and provide hands-free audio monitoring and communication to unsecured locations.
12. The controller shall not need direct connection to any classroom via home run or distributed wiring. It shall communicate solely through the IP network.
13. The system shall provide single-button access from any telephone on the system to distribute emergency announcements within the facility to all or select locations equipped with speakers. Emergency announcements originating from any assigned administrative telephone shall have priority over all regular system functions.
14. The system shall have the ability for administrative consoles and connected phones to selectively monitor audio at any two-way speaker during an emergency.
15. The system shall store a minimum of 48 hours' worth of bell event schedules, all emergency notification sequences, as well as facility-wide configuration.
16. The system shall have the ability to sync system time to the atomic clock signal or to the school's or district's network time server.
17. The system's SIP Interface shall provide:
18. Audio paging access from any telephone to any single intercom speaker, zone (group) of intercom/paging speakers, or all speakers/paging horns throughout the entire facility.
19. The ability to answer a call-in directed to that SIP extension.
20. The ability to upgrade a call-in directed to that SIP extension
21. Single-button access from any telephone on the system to initiate alarm signals within the facility to all or select locations equipped with speakers. A minimum of 25 separate distinct alarm signals shall be provided. Alarm signals originating from any assigned administrative telephone shall have priority over all regular system functions.

22. The ability to initiate a school-wide emergency including lockdown and evacuate sequences.
23. The system shall have the ability to utilize a web-browser and a microphone connected to the PC to deliver district-wide live emergency paging, pre-recorded messages, and tones from any authorized computer in the facility or the district. The system must be capable of automatically notifying district personnel via the WAN of an alarm condition.
24. The system shall have the ability to automatically broadcast page emergency instructions throughout an entire campus when an alarm (e.g. lockdown, lockout, security, fire) is tripped or manually activated. The emergency instructions are pre-programmed and require no user intervention. The system shall provide redundant alarm annunciation over intercom/paging speakers, and is not meant to replace primary fire alarm or security systems.
25. Rauland Telecenter U Campus Controller Model TCC2000, Provide One.

C. IP-Addressable Modules
1. The system shall provide multiple IP addressable modules for intercom, paging, and relay activation.
2. All modules shall be POE 802.3af compliant.
3. All modules shall support DHCP.
4. All modules shall connect to the network with a single RJ45 connector.
5. The IP-addressable speaker module shall interface to school's data network, a speaker, and multiple call switches.
6. The IP speaker module shall provide a minimum of five levels of call-in to be placed.
    a. The call-ins shall route to a designated administrative console and select SIP connected telephones, and can only be cleared from the system once answered.
        1) If a call-in is not answered within a pre-programmed time, the call-in may reroute to other telephones and consoles, and announce over selected or all speakers.
7. An option for privacy call-in switches shall be supported.
    a. When the privacy switch is activated it shall prevent administrative or classroom telephones from monitoring the specific two-way intercom speaker location.
8. The IP-addressable speaker module shall have the ability to belong to one or more of a minimum of 100 independent zones for zone paging, program/music distribution zones, and class change tone reception; this assignment is a programmable function, changeable by time of day. Each IP speaker module's location shall be programmed in software to belong to any combination of software zones. IP speaker modules shall be designed to mount near ceiling and wall speakers and in the plenum space.
9. Rauland IP Classroom Module Model TCC2011, Provide as required.
10. IP-Addressable Zone Paging Module
11. The zone paging module shall connect multiple speakers for district all page, all page, zone paging, bells, audio events, and emergency notification.
12. Zone paging modules shall be rack and wall mountable.
13. Zone paging modules shall be able to belong to one or more of 100 independent zones for live paging, bells, pre-recorded audio, and emergency notification.
14. Rauland Zone Page Module Model TCC2022, Provide as required.
15. IP-Addressable Auxiliary Input/Output Module
16. The auxiliary input/output module shall have two input contacts and two output contacts.
17. The Input and output contacts shall be individually addressable.
18. The auxiliary input/output module shall be wall and rack mountable.
19. The user shall be able to program relays to be activated manually, through an event/bell schedule, and during emergency notification.
20. Rauland Auxiliary Input/Output Module Model TCC2033, Provide as required.

D. IP Addressable Administrative Console

1. The IP-addressable administrative console shall have a full color screen with 64 programmable soft touch buttons, three line select buttons, two volume control buttons, a push-to-talk button, speakerphone mode, and left/right and up/down scrolling.
2. Audio paging access shall be allowed from any console to any single intercom speaker, zone (group) of intercom/paging speakers, or all speakers/paging horns throughout the entire school.
3. Soft key buttons on any console on the system shall have the ability to be programmed to initiate alarm signals within the school to all or select locations equipped with speakers. A minimum of 25 separate distinct alarm signals shall be provided. Alarm signals originating from any assigned administrative telephone shall have priority over all regular system functions.
4. Soft key buttons on any console on the system shall have the ability to be programmed to automatically broadcast page emergency instructions throughout an entire school when an alarm (e.g. lockdown, lockout, security, fire) is tripped or manually activated. The emergency instructions are pre-programmed and require no user intervention. The system provides redundant alarm annunciation over intercom/paging speakers, and is not meant to replace primary fire alarm or security systems.
5. The console shall have the ability to perform intercom functions to any single IP-addressable speaker module.
6. The console shall have the ability to display three call-ins at a time on the screen, with unlimited number of call-ins annunciating and the ability to scroll to view all call-ins.
7. The console shall have the ability to upgrade a call-in via a soft key.
8. Any console shall have programmable soft key access for activating relays, campus wide.
9. The console shall have the ability to maintain, along with the controller and other IP modules, system functions, including intercom, bells, and paging for the local campus in the event of district-wide connection loss.
    a. Rauland Administrative Console Model TCC2044 Provide one for Main office area.

E. Audio Paging/Program Amplifiers
1. Power amplifier(s) shall be provided to provide a minimum of 2 watts of power to all paging speakers, and 15 watts of power to all paging horns.
2. The maximum load on the paging/program amplifiers shall be 80% of the rated maximum output of the amplifiers.

F. Normal/Emergency Dual-Button Call-In Switch
1. Normal/emergency dual-button call-in switches, in locations as indicated on the drawings, shall provide the following functions and features:
2. One “normal” button that shall activate a distinctive call level from single button activation. The button shall be clearly marked “NORM”, and will route the call-in to any administrative console for quick and easy response from an administrative console.
3. One “emergency” button that shall activate a distinctive call level from single button activation. The button shall be red in color, and shall be clearly marked “EMERGENCY”. This button will route the call-in to any administrative consoles for quick and easy response from an administrative console.
4. Rauland Dual Push Button RJ45 Call Switch Model 603302, Provide as shown on drawings.

G. Master Clock
1. System shall provide, network time synchronization throughout the facility, automatic Daylight Saving Time correction, and ability to offset time +/- 15 minutes (in 1 minute increments) from atomic time.
2. Master clock must have front panel display showing current time, connection status, and setup information.

a. Rauland Atomic to Master Clock Synchronization Model TCAMCS

H. Clock Power Supply
1. The clock power supply shall provide 24VAC power for all analog and digital secondary clocks requiring a 24VAC power supply. The clock power supply shall be able to provide power and correct up to 12 digital secondary clocks or up to 200 analog clocks on each output.
2. The clock power supply shall have two 24VAC outputs providing 3.5 amps each, and power input of 120VAC, 60 Hz, 1.5 Amps.

I. Clock Interface Module
1. The clock interface module shall provide a direct interface between the Intercom System, master clock, secondary clocks, and network time synchronization. The clock interface module shall supply the clock correction signals to synchronize the to an atomic time server.
2. The clock interface module shall draw a maximum of 500 mA from a 5.0 VDC supply with all relays energized.
a. Rauland model TCCKINFM.

J. Digital Secondary Clock Module
1. The digital secondary clock module shall have a full 1.8” high red LED numeral display. Automatic correction by the master program clock shall be provided every 24 hours, after a power failure, or whenever time is changed on the master clock. The clock shall operate from 24/120 volts AC, 50 to 600 Hz.
a. Rauland-Borg model 2420.

K. Digital Clock/Speaker Grille and Enclosure
1. The digital clock/speaker grille shall include a faceplate with painted black finish, integral clock mounting bracket, and integral speaker mounting bracket. The grille shall be formed from 18-gauge steel and measure 12.688” square. It shall feature a square perforated area with welded studs for mounting an 8” speaker and a cutout for mounting a digital clock.
a. Lowell model DC802-DR1.
2. Where flush mounted, the grille shall be mounted to a metal protective enclosure constructed of 20-gauge steel with a fire-retardant foam pad to help absorb speaker resonance. The finish shall be black powder epoxy.
a. Lowell model RE1175.
3. Where surface mounted, the grille shall be mounted to a metal protective enclosure constructed of 20-gauge steel with a fire-retardant foam pad to help absorb speaker resonance. The enclosure shall be finished in a white powder epoxy.
a. Lowell model SE1275.
b. Alternate Bid: Provide a fully IP addressable display clock with scrolling messages.

L. Analog Clock/Speaker Grille with Loudspeaker
1. The analog clock/speaker grille shall be constructed of 20-gauge cold-rolled steel, and be finished in baked cool gray epoxy. The grille shall measure 20.40” high by 14.4” wide by 0.5” deep.
2. The grille shall include an 8” loudspeaker which shall be of the magnet seamless cone type, with an additional cone to extend high frequency response. The loudspeaker shall have a frequency range of 65 Hz to 17 kHz, a power rating of 8 watts RMS, and a sensitivity of 93 dB at 1 meter with 1 watt input.
a. Rauland model ACCSACX.

M. Flush Back Box for Analog Clock/Speaker Back Box
   1. The flush back box shall be constructed of 20-gauge cold rolled steel, and shall be finished in baked cool gray epoxy. The back box shall measure 18.5" high by 10.75" wide by 3.75" deep. The back box shall support either vertical or horizontal mounting.

N. 16" Analog Secondary Clock
   1. The 16" analog secondary clock shall have a high-durability ABS enclosure, and a shatter-resistant polycarbonate lens. The diameter of the clock face shall be no less than 14-7/8" in diameter, so the numbers can be seen in large areas such as gymnasiums and other common areas. The clock shall provide indication of improper electrical connection and/or lack of time synchronization signal.
      a. Rauland-Borg model WAC16L

O. Wire Guard
   1. The wire guard shall be constructed of 7-gauge steel wire, welded at all points, and finished in nickel plating with lacquer coating. It shall be provided with two welded hinges and a mounting plate for a solid installation.
      a. Chase model CWG-18187

P. Wall-Mounted Square Grille and Flush Back Box
   1. The square grille shall be constructed of one-piece, heavy gauge cold rolled steel with a square loudspeaker cutout and perforated grille. The grille shall be 12-5/8" square. The grille shall be finished in textured white epoxy with a black loudspeaker sub-plate.
      a. Atlas model 164-8A.
   2. The flush-mount back box shall be constructed of 20-gauge steel, and shall measure 11.75" square by 4" deep. The back box shall feature combination knockouts on four sides, and include a foam pad. The back box shall have black powder epoxy finish.
      a. Lowell model RE1175.

Q. Flush-Mount Weatherproof Loudspeaker
   1. The loudspeaker shall be 8" in diameter with a 10-ounce magnet. The speaker shall have a phenolic resin impregnated, moisture resistant cone.
   2. The loudspeaker shall have a power rating of 20 watts, and nominal coverage of 100 degrees. Calculated output shall be 101 dB SPL, 5 watts at 1 meter.
      a. Quam model 8C10PAOT.
   3. The transformer shall provide 5 watts at 25/70.7 volts with five taps at -3 dB levels.
      a. Quam model TBLU.

R. Vandal-Proof Grille
   1. The vandal-proof exterior speaker grille shall be manufactured from self-aging aluminum alloy which has a tensile strength of 44,000 psi. Each grille shall have a perforated 22-gauge cold rolled steel stud-mounting loudspeaker plate. Flush-mounting tamperproof heat-treated alloy screws and a special wrench shall be furnished. The finish of the grille shall be textured white epoxy.
      a. Atlas model VP161A-R8.
   2. The flush speaker back box shall be welded of cold rolled steel construction, and be undercoated to eliminate mechanical and acoustical resonances.
      a. Atlas model 193-8.
   3. The surface speaker back box shall be constructed of heavy-duty 16-gauge cold rolled steel, and be finished in a textured white epoxy.
      a. Atlas model SE161-R.

S. Equipment Rack

1. Rauland-Borg Telecenter U shall be installed in the owner's data racks configured as approved by the engineer.
2. All head-end, distribution, and source equipment, including data and power, shall be located in the owner's data racks configured as approved by the engineer. Coordinate with Section 27XXXX as required for the installing contractor to install the system equipment within these racks.
3. Rack-mounted equipment shall be accessible from front and rear.
4. All unused rack spaces will be covered with appropriate blank or vent panels, if required.

T. Materials Not Included (Provided and Installed by Others.)
1. Switchers, routers, network hubs, data concentrators, and other similar active electronic equipment for data network telecommunications.
2. Computers, printers, modems, and other similar utilization equipment.
3. Telephone system, telephone switching equipment, and related appurtenances.
4. All server hardware and SQL software.

U. Accessories
1. Volume Control
2. Call switch

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install system in accordance with all applicable codes, and in accordance with manufacturer's written instructions.

B. Data Contractor Section 27XXXX is responsible for all network cables to all clock speaker combo locations. One terminated drop per locations shown on plans.

C. Coordinate cable locations with Section 27XXXX Data and Voice Infrastructure Installing Contractor as Required.

D. Furnish and install all material, devices, components, and equipment for a complete operational system.

E. Impedance and Level Matching: Carefully match input and output impedances and signal levels at signal interfaces.

F. The electrical contractor shall provide necessary transient protection on the AC power feed, all copper station lines leaving or entering the building, and all central office trunks. All protection shall be as recommended by the equipment supplier and referenced to earth ground.

G. Wiring within Enclosures: Provide adequate length of conductors. bundle, lace, and train the conductors to terminal points with adequate service loop.

H. Weatherproofing: Provide weatherproof enclosures for items to be mounted outdoors or exposed to weather.

3.2 GROUNDING

A. Provide equipment grounding connections for Integrated Electronic Communications Network systems as indicated. Tighten connections to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounds.

B. Ground equipment, conductor, and cable shields to eliminate shock hazard and to minimize to the greatest extent possible, ground loops, common mode returns, noise pickup, cross talk, and other impairments. Provide 5 ohm ground at main equipment location. Measure, record, and report ground resistance.

3.3 CLEANING AND PROTECTION

A. Prior to final acceptance, the contractor shall clean all system components and protect them from damage and deterioration. All general areas within and around all equipment rack will be swept and cleaned up.

3.4 MAINTENANCE DATA

A. Provide a record of owner's equipment and programming.

B. Provide Installation manuals and User Guides provided by the manufacturer.

3.5 RECORD DRAWINGS

A. Provide three complete sets of drawings indicating all construction details in accordance with the actual system installation. Revise all shop drawings to represent actual installation conditions.

3.6 IN-SERVICE TRAINING

A. The contractor shall provide and implement a complete and comprehensive staff training program for all administrators, facility staff members, and teachers. This mandatory training program will provide school staff a complete understanding of how to utilize and properly operate all functions.

B. The training program shall be implemented by a staff member/trainer employed by the contractor. The trainer must be factory certified to provide training on their product.

C. All staff development training is to be coordinated through the owner's designated representative. As training sessions are completed, the trainer will provide the school's administrative staff and school district's staff a document listing all of the staff and faculty members who attended, received, and completed the training program.

D. The trainer shall provide custom user guides for system operation to administrative personnel at the training session.

E. A room and campus directory shall also be provided at the time of training to each staff member of the facility. It shall show the final configuration of the campus, and list the correct room and dial numbers.

3.7 COMMISSIONING

A. The contractor shall train the owner's maintenance personnel in the procedures and schedules involved in operating, troubleshooting, servicing, and preventative maintenance of the system.

B. Schedule training with the owner through the owner’s representative, with at least seven days advance notice.

3.8 WARRANTY

A. Provide a manufacturer’s five-year warranty of the school communications network equipment against defects in material and workmanship. This warranty will cover all electronic equipment added to extend the system, as well as analog or digital clocks, speakers, and call-in switches added to the system. If any defects are found within the warranty period, the defective equipment shall be replaced at no cost (equipment only); a two-year warranty shall be provided for labor.

B. A copy of the manufacturer’s standard statement of warranty proving all equipment provided for the school communications network is covered with the required five-year warranty shall be included with the project submittal. This statement of warranty shall be provided on the manufacturer’s stationary. The standard five-year warranty is an important element in establishing a standard in quality. Manufacturers who circumvent the five-year warranty by offering special “extended warranties” that are not part of their normal published warranty will not be accepted.

C. Contractor shall respond, excluding weekends and holidays, within 24 hours to any warranty service calls. If equipment cannot be repaired within 24 hours of service visit, the contractor shall provide “loaner” equipment to the facility at no charge.

D. Make available a service contract offering continuing factory authorized service of the system after the initial warranty period.

END OF SECTION 275123

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Provide a complete and fully operation Access Control system for the facilities listed. Contractor shall provide all items specified below and other accessories required for a complete and fully functional access control system.

B. Provide the LP1502 System controller in the 200 Building MDF and link to MR62 door controllers in the building via the data network.

C. Include all Genetec Synergis Enterprise software, licensing, firmware upgrades required for the entire project. All software to be installed on district servers.

D. System shall include a panic button at location directed by the owner. This button shall connect to system and when pressed shall lock all exterior doors and release internal magnetic doors. Button shall inititate fire alarm page and intercom page. Provide contacts to those systems.

E. The system generally has electric latch retraction doors, which require over 1 Amp of power and are not capable of being powered from the POE door controllers. The access control system shall provide power from power supplies in the MDF and IDFs as shown on the drawings for all doors. Hardware is not providing any power supplies. No 120 volt circuits or power supplies will be located at the doors. Coordinate with hardware supplier and size all power supplies to match the installed equipment with 20% spare.

F. Provide key switch override for electric latch retraction doors where shown on the contract documents. Switch is furnished by Hardware, installed and wired by access control contractor.

G. Provide DPDT door switches. Door switches will connect to the security system via existing wire and to the access control system.

H. Request to exit are provided with the electronic latch retraction device and shall be wired by the access control contractor.

I. Where door is not electronic latch retraction, access control contractor shall provide a request to exit above the door.

J. Link system to the Bosch Security System

1.2 INSTALLER QUALIFICATIONS

A. Access control contractor must be a Genetec approved installer,
   1. Access control contractor must have been in business for 10+ years in the Electronic Security Industry and installed a minimum of 5 access control systems in schools similar to this contract.
   2. Access control contractor must have a fully staffed (installation and service department) office within a 150 mile radius of site
   3. Access control contractor must have a min of (3) fulltime service technicians working/dispatched from office within a 150 mile radius of site

4. Have installed 2 POE access control systems

1.3 DEFINITIONS

A. API: Application Programming Interface.

B. LDAP: Lightweight Directory Access Protocol.

C. NTSC: National Television Standards Committee.

D. PAL: Phase Alternating Line. PAL is the color video standard used in Europe and many other countries.

E. SMS: Security Management System.

1.4 REFERENCE STANDARDS

A. Where more than one (1) reference standard, code, or regulation applies, the more stringent one shall govern.

B. Electronic Industries Alliance (EIA):
1. EIA RS-170 - Standard for Composite Video Signals.

C. Federal Communications Commission (FCC).
1. FCC Part 15 - Unlicensed RF Devices.
2. FCC Part 68 - Requirements for Connecting to the U.S. Phone Network. F. Institute of Electrical and Electronics Engineers, Inc. (IEEE).

D. International Organization for Standardization (ISO). H. International Radio Consultive Committee (CCIR).

E. Microsoft® Open Database Connectivity (ODBC) Interface.

F. National Fire Protection Association (NFPA):
1. NFPA 70 - National Electrical Code.

G. National Institute of Standards and Technology (NIST):
1. Federal Information Processing Standards Publication (FIP PUBS 197) - Specification for the Advanced Encryption Standard (AES).

H. National Television Standards Committee (NTSC):
1. Color Camera Broadcast Standard.

I. Underwriters Laboratories Inc. (UL):
1. UL 294 - Standard for Access Control System Units.
2. UL 1076 - Standard for Proprietary Burglar Alarm Units and Systems.

1.5 SECURITY MANAGEMENT SYSTEM (SMS) DESCRIPTION

A. Provide a Genetec Synergis Enterprise software package and install on district provided server

B. The Security Management System (SMS) outlined in this section and detailed in Part 2 of this section is the key central component for managing physical security and the bridge between physical and logical security for a project. The system shall provide a variety of integral functions including: regulation of access and egress; provision of identification credentials; monitor, track and interface alarms and; view, record and store digital surveillance video linked to SMS events.

1.6 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Reference each product to a location on Drawings.
   1. Manufacturer's technical data for all material and equipment at the system and sub system level to be provided as part of the System.
      a. Server(s) processor(s), disk space and memory size.
      b. Description of site equipment and its configuration.
      c. Network bandwidth, latency and reliability requirements.
      d. Backup or archive system size and configuration.
      e. Start up operations.
      f. System expansion capability and method of implementation.
      g. System power requirements and UPS sizing.
      h. Device or component environmental requirements (cooling and or heating
      i. parameters).
      j. A description of the operating system and application software.

B. Shop Drawings: Submit plans, elevations, sections, details, and attachments to other work.
   1. Indicate all system device locations on architectural floor plans. No other system(s) shall be included on these plans.
   2. Include full schematic wiring information on these drawings for all devices. Wiring information shall include cable type, conductor routings, quantities, and connection details at device.
   3. Include a complete access control system one-line, block diagram.
   4. Include a statement of the system sequence of operation.

C. Operation and Maintenance Data: For electronic security system to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 78 23, include the following:
   1. Provide 5 sets electronic format manuals including operating instructions, maintenance recommendations and parts list including wiring and connection diagrams modified to reflect as-built conditions.
   2. Manuals: Deliver final copies of the manuals after completing the installation test. Each manual's contents shall be identified on the cover. The manual shall include names, addresses, and telephone numbers of the Contractor responsible for the installation and maintenance of the system and the factory representatives for each item of equipment for each system. The manuals shall have a table of contents and labeled sections. The final copies delivered after completion of the installation test shall include all modifications made during installation, checkout, and acceptance testing. The manuals shall consist of the following:
      a. Functional Design Manual: Identify the operational requirements for the system and explain the theory of operation, design philosophy, and specific functions. Include a description of hardware and software functions, interfaces, and requirements.
      b. Hardware Manual: Describe equipment furnished including:

1) General description and specifications.
2) Installation and check out procedures.
3) Equipment layout and electrical schematics to the component level.
4) System layout drawings and schematics.
5) Alignment and calibration procedures.
6) Manufacturer's repair parts list indicating sources of supply.

c. Software Manuals: Describe the functions of software and include all other information necessary to enable proper loading, testing, and operation. The manual shall include:
1) Definition of terms and functions.
2) System use and application software.
3) Initialization, startup, and exit.
4) Reports generation.
5) Details on forms customization and field parameters.

3. As-Built Drawings: During system installation, the Contractor shall maintain a separate hard copy set of drawings, elementary diagrams, and wiring diagrams of the access control system to be used for record drawings. This set shall be accurately kept up to date by the Contractor with all changes and additions to the access control system. Copies of the final as-built drawings shall be provided to the end user in DXF format.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications

B. The manufacturers of all hardware and software components employed in the SMS shall be established vendors to the access control/security monitoring industry for no less than five (5) years and shall have successfully implemented at least 5 systems of similar size and complexity.

C. Contractor / Integrator Qualifications
1. The security system integrator shall have been regularly engaged in the installation and maintenance of integrated access control systems and have a proven track record with similar systems of the same size, scope, and complexity.
2. The security system integrator shall supply information attesting to the fact that their firm is an authorized product integrator certified with the SMS. A minimum of one technician shall be a Certified SMS installer.
3. The security system integrator shall supply information attesting to the fact that their installation and service technicians are competent factory trained and certified personnel capable of maintaining the system and providing reasonable service time.
4. The security system integrator shall provide a minimum of three (3) references whose systems are of similar complexity and have been installed and maintained by the security system integrator in the last five (5) years.
5. There shall be a local representative and factory authorized local service organization that shall carry a complete stock of parts and provide maintenance for these systems.

D. Testing Agencies
1. The SMS shall be tested and listed by Underwriters Laboratories (UL) for UL/cUL 294 for Access Control System Units.
2. The SMS shall be tested and listed by Underwriters Laboratories (UL) for UL/cUL 1076 for Proprietary Burglar Alarm Units.
3. The SMS shall employ a FIPS 197-listed AES 256-bit encryption between the SMS Servers, Clients, and iSTAR Ultra/eX/Edge Controllers.

4. The SMS shall include full support for FIPS 201 initiative:
5. Ability to customize a system-wide Card Holder Unique IDentification number (CHUID).
6. Ability to configure custom, extended card formats, including GSA 75-bit Wiegand standard, and to download them to the card access panels.
7. Ability to use Hashed Message Authentication Codes (HMAC) for medium assurance profile.
8. Enhanced data fields per the FIPS 201 standard, including Agency Code, System Code, Credential Series and Credential Issue Code.
9. The SMS hardware shall comply with the following regulatory requirements:
    a. FCC Class A.
    b. FCC Class B.
    c. CE.
    d. The SMS shall support Americans with Disabilities Act (ADA) compliance in door and access operation.

1.8 DELIVERY, STORAGE AND HANDLING

A. Deliver, store, and handle materials, components, and equipment in manufacturer's protective packaging.

B. Store components and equipment in temperature and humidity controlled environment in original manufacturer's sealed containers. Maintain ambient temperature between 50 and 85 degrees Fahrenheit (10 and 29.4 degrees Celsius), and not more than 80 percent relative humidity, non-condensing.

C. Open each package; verify contents against packing list; and file copy of packing list, complete with package identification, for inclusion in operation and maintenance data.

D. Mark packing list with the same designations assigned to materials, components, and equipment for recording in the system labeling schedules that are generated by software.

E. Save original manufacturer's containers and packing materials and deliver as directed under provisions covering extra materials.

1.9 PROJECT CONDITIONS

A. Environmental Conditions: System shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
    1. Equipment and Components: Rated for continuous operation in ambient conditions of 60 to 85 degrees Fahrenheit (15.5 and 29.4 degrees Celsius) and a relative humidity of 20 to 80 percent, non-condensing.
    2. Indoor Environment: NEMA 250, Type 1 enclosure.
    3. Outdoor Environment: NEMA 250, NEMA 250, Type 4 enclosures.

1.10 WARRANTY

A. Provide one year complete travel, and labor warranty for the entire system from date of substantial completion.

B. All SMS manufacturer branded access control hardware is provided with a three (3) year warranty from the date of project substantial completion. SMS manufacturer warrants that such products will be free from defects in material and workmanship and that they will operate in general accordance with their product specifications. The parts will be repaired or replaced at the manufacturer's option. Reseller shall follow SMS manufacturer's procedures for RMA with these products. SMS manufacturer provides repair or replacement of SMS manufacturer branded components for up to five years from the product is continuance date

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Basis-of-Design Manufacturer: The security management system is based on products of Genetec Synergis Manager Enterprise with Mercury Hardware and all power supplies and controllers to be POE to feed power to door locks provided in hardware specification

2.2 SERVER

A. Server – By owner. Install software on owner provided server)

2.3 SPARE PARTS

A. Provide (2) additional door controllers

B. Provide (1) additional card reader

2.4 SMS SOFTWARE

A. Security Management System (SMS) Software Genetec– as many as required for door count shown on drawings) for district wide deployment. Include all components necessary for a complete and fully operational access control system. Provide all additional licensing as required for a complete and fully functional system.

2.5 SERVER

A. Furnish the SMS Server specifications to the owner to meet the software requirements

B. Client Workstations: Provide specs to owner for workstations and desktops provided by the owner

2.6 EQUIPMENT

A. Security Management System (SMS) Hardware: The SMS shall be equipped with the access control field hardware required to receive alarms and administer all access granted or denied decisions. All field hardware must be designed to meet UL 294

B. The SMS must be able to retrieve device serial numbers from all field hardware, excluding card readers, biometric readers, and keypads. Depending upon the configuration, the SMS field hardware must be able to include any or all of the following components:
   1. Connectivity Software License – Genetec Synergis licenses for entire system
   2. System Controller – LP1502 series. All door controllers are POE, see below
      a. The interface is for use in low voltage, Class 2 Circuits only.
      b. The installation of this device must comply with all local fire and electrical codes.
      c. Primary Power: 12 to 24 Vdc ± 10 %, 500 mA maximum (reader and USB ports not included)
      d. Reader Ports 600 mA maximum (add 600 mA to primary power current)
      e. Micro USB Port 5 Vdc, 500 mA maximum (add 270 mA to primary power current)
      f. Memory and Clock Backup Battery: 3 Volt Lithium, type BR2330 or CR2330
      g. microSD Card: Format: microSD or microSDHC; 2GB to 8GB
      h. Host Communication: Ethernet: 10-BaseT/100Base-TX and Micro USB port (2.0) with optional adapter: pluggable model USB2-OTGE100
      i. Serial I/O Device One each: 2-wire RS-485, 2,400 to 115,200 bps, asynchronous, half-duplex, 1 start bit, 8 data bits, and 1 stop bit
      j. Inputs: Eight unsupervised/supervised, standard EOL: 1k/1k ohm, 1%, ¼ watt Two unsupervised dedicated for cabinet tamper and UPS fault monitoring
      k. Outputs: Four relays, Form-C with dry contacts Normally open contact (NO) contact: 5 A @ 30 Vdc resistive Normally closed contact (NC) contact: 3 A @ 30 Vdc resistive
      l. Reader Interface
         1) Power: 12 Vdc ± 10 % regulated, 300 mA maximum each reader (jumper selectable) (input voltage (VIN) must be greater than 20 Vdc) or 12 to 24 Vdc ± 10 % (input voltage (VIN) passed through), 300 mA maximum each reader
         2) Data Inputs: TTL compatible, F/2F or 2-wire RS-485
         3) RS-485 Mode: 9,600 to 115,200 bps, asynchronous, half-duplex, 1 start bit, 8 data bits, and 1 stop bit. Maximum cable length: 2000 ft. (609.6 m)
         4) LED Output: TTL levels, high>3 V, low<0.5 V, 5 mA source/sink maximum
         5) Buzzer Output: Open collector, 12 Vdc open circuit maximum, 40 mA sink maximum
      m. Cable requirements
         1) Power and Relays: 1 twisted pair, 18 to 16 AWG
         2) Ethernet: CAT-5, minimum
         3) RS-485
         4) (I/O Device Port): 1 twisted pair, shielded, 120 ohm impedance, 24 AWG, 4,000 ft. (1,219 m) max.
         5) (Reader Port): 1 twisted pair, shielded, 120 ohm impedance, 24 AWG, 2,000 ft. (610 m) max.
         6) Alarm Input: 1 twisted pair, 30 ohms maximum
      n. Product Compliance
         1) UL294 Recognized
         2) FCC Part 15 Class A
         3) CE Compliant
         4) RoHS (2011/65/EU & 2015/863)
         5) EU REACH (1907/2006)
         6) California Proposition 65
         7) NIST Certified Encryption
      o. Warranty: Mercury Security warrants the product is free from defects in material and workmanship under normal use and service with proper maintenance for one year from substantial completion.
      p. Technical Features

1) Connectivity: 10/100 Ethernet. Optional alternate 10/100 Ethernet (using USB/Ethernet converter)
2) Security:
   a) Host/Controller connection protected by TLS 1.2/1.1 or AES-256/128
   b) Controller/IO Expansion connection protected by AES
   c) Generate and load custom peer certificates for TLS
   d) Port based network access control using 802.1X
   e) Crypto memory chip
   f) FIPS 140-2 user of OpenSSL
   g) HTTPS protection for installer web pages
   h) Secure cookies
   i) SNMPv3/v2c
   j) DIP switch toggle sets 5 minute time to disable webpage access
   k) Disable default login credentials
   l) Authorized IP address filtering
   m) IP Client Proxy
   n) Bulk erase controller and periphery devices during replacement
   o) Strong password enforcement
3) Door Control:
   a) Two-reader ports: Clock and Data, Wiegand, or RS-485
   b) Eight programmable inputs, four relays, diagnostic LEDs
4) Access Control:
   a) 240,000 Cardholder capacity
   b) 50,000 Transaction buffer
   c) If/Then Macro capability
   d) Adjustable cardholder capacity
   e) Supports up to 520 inputs and 516 outputs
5) Card Formats:
   a) 16 card formats per active reader, 8 per offline reader
   b) Entire card number reported on invalid read
   c) 19 digit (64-bit) User ID and 15 digit PIN numbers maximum
   d) PIV, CAC, TWIC card compatible
   e) 255 Access Levels per cardolder
   f) Activation/Deactivation Date or Date & Times
6) Card Reader Functions
   a) Multiple card format support by reader
   b) Paired reader support
   c) Alternate reader support
   d) Elevator support
   e) Turnstile support
   f) Biometric device support
   g) Open Supervised Device Protocol (OSDP) and OSDP SC compliant
   h) Occupancy count
   i) Support of multi-occupancy rules
   j) Anti-passback support
   k) Area-based, reader-based, or time based
   l) Nested area, hard, soft, or timed forgiveness
7) Supports host-based approval rules
8) Keypad support with programmable user commands, card input
9) Shunt relay support
10) Strike follower relay support
11) Threat level and Operating Modes
12) Host controlled OSDP reader passthrough
13) Elevator floor override

14) Database Functions
    a) Encrypted database
    b) Configurable card database
    c) Supports up to nineteen (19) digit card numbers
    d) Supports pin codes up to fifteen (15) digits
    e) Card issue code of up to 32 bits, ADA and VIP flags; PIV (75 bits); Smart Card (200 bits)
    f) Ability to track people and objects
15) Intrusion Alarm Functions
    a) Supports entry delays and exit delays
    b) Area monitoring
    c) Standard alarm masking
    d) Provides control and alarm processing from the keypad
16) Supported Integrations
    a) Regional I/O shares I/O status
    b) Wireless locks
    c) Map Power Supply Alarms and Events using PSIA
    d) Reader firmware and configuration download
    e) Supports 1 total RS-485 I/O protocols
17) System Functions
    a) Relay count activations
    b) Interoperability with older host software using Legacy Mode feature
    c) Synchronize time using NT

3. Reader Modules (sing or dual reader modules with POE) – AC-MER-COM-MR62E
   a. The MR62e is for use in low voltage, Class 2 circuits only.
   b. Power Input
      1) PoE (12.95 W), compliant to IEEE 802.3af or
      2) PoE+ (25 W), compliant to IEEE 802.3at or
      3) 12 Vdc +/-10 %, 1.7 A maximum
   c. Power Output
      1) PoE: Readers and Lock, combined: 12 Vdc @ .66 A maximum
      2) PoE+ or 12 Vdc: Lock 12 Vdc @ 1 A maximum, RVO, Readers 12 Vdc @ .5 A maximum
   d. Output: Four relays, Form-C contacts rated at 2 A @ 30 Vdc
   e. Inputs: Six unsupervised/supervised, End of Line resistors, 1k/1k ohm, 1%, ¼ watt standard
   f. Reader Interface
      1) Power: 12 Vdc @ .5 A maximum
      2) Communication: 2-Wire RS-485, OSDP protocol, four devices maximum
   g. Cable Requirements
      1) Communication: Ethernet, CAT-5, minimum
      2) External Input Power: 1 twisted pair, 18 AWG (if required)
      3) Alarm Inputs: 1 twisted pair per input, 30 ohm maximum
      4) Relay Outputs: As required for the load
      5) Reader Data RS-485/power: 2 twisted pair with shield, 24 AWG, 120 ohm impedance 4000 foot (1220 m) maximum. or RS-485: 1 twisted pair with shield, 24 AWG, 120 ohm impedance, 4000 foot (1220 m) maximum and Power: 1 pair 18 AWG* * Type of cable(s) and gauge determined by length and voltage/current requirements. Local power source may be required
   h. Product Compliance
      1) UL294 Recognized. For UL, the Power Sourcing Equipment (PSE) such as a PoE/PoE+ enabled network switch and/or PoE/PoE+ power injectors must be UL Listed under UL294B.
      2) FCC Part 15 Class A

3) CE Compliant
4) ROHS
5) NIST Certified Encryption

4. I/O Modules: AC-MER-CON-MR16IN and OUT
5. SDC kit for lock – Furnished by Hardware, installed by Access Control Contractor. Similar to Sargent LR100SGK
6. Dual Contact Door Contacts – DPDT – Interlogix GE 1076C-XXX Series with 1840-N rare earth magnet - Reports to access control and security systems.
7. Interface to Bosch Security Panel: D9412GV2/GV3/GV4 Intrusion panel GV2: ver. 7.08, GV3: ver.8.04 8.14, GV4: ver. 1.04 Certified
8. Panic/Lockdown Button: Yellow, “Lockdown” label with protective guard and flush backbox. Cut and patch wall to install. STI#2221LD-EN. Locks all doors on activiation.
9. Door Unlock Button: Green with stainless plate, labeled “Push to Exit”. STI UB1
10. Proximity Readers
    a. Iclass Multiclass SE. RP40 (or RP15 if necessary and approved)
    b. Dimensions: 3.3" x 4.8" x 1.0" (8.4 cm x 12.2 cm x 2.4 cm)
    c. 125 kHz contactless cards supported
    d. HID Prox®, Indala® Prox, Dorado® Prox, and EM Prox legacy contactless credentials
    e. 13.56 MHz contactless smart cards supported
    f. iCLASS Seos® , ICLASS SE, iCLASS®, MIFARE® Classic, and MIFARE DESFire®EV1
    g. Protocol
    h. Open Supervised Device Protocol (OSDP) mode
    i. Wiegand or Clock & Data modes
11. Request to Exit – Securitron XMS motion detector.
12. FOBS/Cards: Provide 500 School District standard proximity fobs or access control cards with this project per the Northshore School District Standard. District will assist with ordering. HID Multi/Iclass SE. Assist district is selecting the card standard for the district.
13. Electric Locks: Coordinate with hardware specification. Provide all power supplies for specified latch retraction devices. Electric strikes are powered from POE controller.
14. ADA Relay Adaptor: Spaceage SSU-PAM-4. ADA Doors: Provide relays required to interface to ADA automatic door systems.

C. Power Supplies: Lifesafety Power FP0150 or Altronix AL4000. Coordinate with the hardware contractor and provide power for all locks connected to the system. Locate power supplies at access control junction boxes and run power cabling to all doors. All shall be POE unless not possible. Battery backup for all power supplies. Minimum 25% spare battery capacity.

D. Data Switches
1. Owner will provide switches for the system
2. Provide all patch cords for the system. Category 6 per 271500

E. Cabling
1. Network and Power cable are provided under 271500. Power cable is shown to be 4 conductor#18. Access control contractor shall confirm this cable, provide voltage drop calculations and notify 271500 contractor as to exact type.
2. All other cabling (Card Reader, REX, Key Switch, etc.) is provided under this section and is generally #18 or as required by the manufacturer. Provide plenum rated open cable whenever in a plenum

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of electronic security system.

B. Examine rough-in for embedded and built-in anchors to verify actual locations of intrusion detection connections before electronic security system installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SYSTEM INTEGRATION

A. Integrate electronic security system with the following systems and equipment:
1. Electronic door hardware.
2. Security system.

3.3 PROGRAMMING

A. Programming system configuration parameters shall be as directed by the owner. The contractor shall attend a meeting and review the entire system with the owner and program as directed. The programming parameters shall be written by the contractor and approved by the owner or the system is not considered programmed to the owner's needs. After 3 months return to the site and adjust all programming as directed by the owner.

3.4 INSTALLATION

A. Install electronic security system in accordance with manufacturer' written instructions.

B. Wiring Method: Install wiring in metal raceways in exposed areas and above non-accessible ceilings. Conceal raceway except in unfinished spaces and as indicated. Minimum conduit size shall be 3/4-inch. Control and data transmission wiring shall not share conduit with other building wiring systems. Cable, concealed in accessible ceilings, walls, and floors when possible.

C. Installer shall fully program the system to accommodate all new devices and cards on this project. Program all cards as directed by the district.

D. Integrate system to the Bosch D9412GV4 security panel. The interior access control card readers shall deactivate the security system and rearm the system.

3.5 TRAINING

A. Provide complete training systems to building users and as well as district maintenance staff. Contractor shall provide 1 training session of 8 hours to building user and 2 sessions of 4 hours each to maintenance personnel. Record all sessions and deliver 3 copies of training sessions to the owner.

END OF SECTION 281300

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Introduction

B. The Contractor shall provide, install, and program a functionally complete, integrated Digital Alarm Communicator and Access Control System (DACS) per Manufacturer's guidelines, codes described, within these specifications. Bosch D9412GV4 or current version.

C. Upgrade the panel in the 200 Building or provide new and link panels together

D. The system will be disarmed by internal card readers and keypads.

E. Work included under this section
   1. System and its components
   2. System wiring (low voltage)
   3. Mounting accessories
   4. System programming
   5. Warranty, service, and training

F. The contractor furnishing the security system shall be the same as the contractor furnishing the access control system in 281300

1.2 GENERAL CONDITIONS

A. Submittals after award of contract
   1. Drawings: Shop drawings to provide details of proposed system and the work to be provided. These include point-to-point drawings of systems and wiring diagrams of individual devices.
   2. Permits: The Contractor shall be responsible for identifying requirements for permits from the local police department for the installation of the alarm system specified herein and shall assist the owner in obtaining the relevant alarm permits.

B. Documentation to be submitted by the Contractor upon completion of system installation
   1. "As-builts": Upon completion of installation, the Contractor shall prepare "as-built" drawings of the system. These "As-builts" shall be 30 in. x 42 in. (76 cm x 107 cm) format mylar reproducible drawings of each floor plan indicating exact device locations, panel terminations, cable routes and wire numbers as tagged and color-coded on the cable tag.
      a. Additionally, final point-to-point wiring diagrams of each type of device (on 30 in. x 42 in. or 76 cm x 107 cm format) shall be included in the "as-builts."
      b. "As-builts" shall be submitted to the Owner for approval prior to the system acceptance walk-through.
   2. Operation and maintenance manuals: Three (3) sets of operating manuals shall be provided explaining the operation and maintenance of the system.

C. On-site security personnel training

D. The Contractor upon completion of installation shall furnish training in the complete operation of the systems.

E. System approvals
   1. The system shall be the standard product of one manufacturer, and the manufacturer shall have been in business manufacturing similar products for at least 5 years.
   2. After-sales support: The Contractor shall be a factory-authorized and trained dealer of the system and shall be factory-trained and certified to maintain/repair the system after system acceptance.

F. Quality assurance

G. All equipment, systems, and materials furnished and installed under this section shall be installed in accordance with the applicable standards of:
   1. National codes: NEC, NFPA, UBC, BOCA, SBCCI
   2. Approvals and listings: UL, FM, (ANSI CP-01, CSFM, NYC-MEA, when applicable)
   3. Local Authorities Having Jurisdiction

H. Warranty

I. All components, parts, and assemblies supplied by the Manufacturers and installed by the Contractor shall be warranted against defects in material and workmanship for a period of at least 12 months (parts and labor), commencing upon date of acceptance by Owner. A qualified factory-trained service representative shall provide warranty service.

J. Service/Maintenance
   1. System maintenance and repair of system or workmanship defects during the warranty period shall be provided by the Contractor free of charge (parts and labor).
   2. Periodic testing of the system shall be carried out on a monthly or quarterly basis to ensure the integrity of the control panel, the sensing devices, and the telephone lines.
   3. The installer shall correct any system defect within six (6) hours of receipt of call from the Owner.
   4. Extended service/maintenance agreements shall be offered by the Contractor for up to four years after the warranty expires. The agreement shall be renewable monthly, quarterly, or yearly.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

2.2 PROVIDE A BOSCH D9412GV4. PROVIDE ALL POPITS, POWER SUPPLIES, MODULES ETC FOR A COMPLETE SYSTEM EXPANSION

A. System
   1. The system shall include the following accessories:
      a. Accessory Description
      b. Provide all modules, power supplies, batteries popits, etc. for a fully functional addressable seucrity system. System may be wired Class B. Provide relays as required for remote control. Provide for connection to UL monitoring system and provide for internet protocol (IP) connections.

B. Security Devices

	Door Switches:
ZX835	PIR/Microwave Detector, 35 ft. (11 m), with built-in POPIT
ZX970	PIR/Microwave Detector, 70 ft. (21 m), with built-in POPIT
D9133TTL-E	
D1255	Keypad: - Built-in multi-tone sounder. Displays status in custom English text on 16-character display. If more than 4 ACCs are required, add D8132 battery charger unit. ACCs provide "command menu" user interface. ACC can be supervised., D1255W for white
	Provide an etherent interface card Ethernet Interface Module. Interface to the Access Control System

C. Access Control System – See 281300

D. Battery Backup
1. Provide for complete battery backup of all systems with minimum 25% spare capacity.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install all equipment and materials in accordance with the "current" recommendations of the manufacturer. The work shall also be in accordance with:

1. Installation criteria defined in these specifications and in the construction documents.
2. Factory Representative shall be the Bosch Security Systems Security Dealer.
3. Approved submittals.
4. Applicable requirements of referenced standards.

3.2 SUPERVISION

A. The contractor shall provide the following services as part of the contract:

1. Supervision of sub-contractors.
2. Coordination of other contractors for system-related work (electrical contractor, finish hardware contractor, architect, and general contractor).
3. Attending site construction/coordination meetings.
4. Keeping updated construction drawings at the construction site.
5. Meeting construction deadlines per the construction schedule.

3.3 PROGRAMMING

A. Programming of the system shall include the following tasks:

1. Programming system configuration parameters (hardware and software, zone/circuit numbers, communication parameters) shall be as directed by the owner. The contractor shall attend a meeting and review the entire system with the owner and program as directed. The programming parameters shall be written by the contractor and approved by the owner or the system is not considered programmed to the owner's needs. After 3 months return to the site and adjust all programming as directed by the owner.
2. Programming operational parameters such as opening/closing reports and windows, system response text (custom English) displays of events, activation of relays that drive auxiliary devices, and identifying types of zones/loops.
3. Programming passcodes according to the authorities and functions defined by the owner.
4. Other system programming tasks required by the owner. These additional programming requirements shall be coordinated between the owner and the contractor.

3.4 TESTING

A. Operational Testing: The contractor shall perform thorough operational testing and verify that all system components are fully operational.

B. Hard-copy System Printout: The contractor shall submit a hard-copy system printout of all components tested and certify 100 percent operation indicating all devices/panels/units have passed the test criteria set forth by the manufacturer.

C. Acceptance Test Plan Form: An acceptance test plan form shall be prepared/provided by the contractor prior to the acceptance walk-through.

D. This form shall include separate sections for each device/panel/unit as well as a column indicating the manufacturer's performance allowance/margin, a column indicating the result of the testing performed by the contractor (pass/fail), and an empty column for recording findings during the walk-through.

3.5 COMMISSIONING

A. The contractor shall certify completion in writing and schedule the commissioning walk-through. The contractor shall provide all the tools and personnel needed to conduct an efficient commissioning process.

3.6 TRAINING

A. The contractor shall provide a minimum of 8 hours training to the district maintenance staff and another 4 hours of on site training to the school staff. Train on the IP

interface and all programming including interface to the access control system. Record all sessions and deliver 3 copies to owner in flash drive or DVD format.

END OF SECTION 281600

PART 1 GENERAL

1.1 SUMMARY

A. Section includes a video surveillance system consisting of cameras, Genetec software and licenses.

B. Cabling is covered in 271500

C. Related Requirements:
1. Section 281300 Access Control System
2. Section 271500 Cabling

1.2 SUBMITTALS

A. Product Data: For each type of product indicated. Include dimensions and data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For video surveillance. Include plans, elevations, sections, details, and attachments to other work.
1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Functional Block Diagram: Show single-line interconnections between components for signal transmission and control. Show cable types and sizes.
3. Dimensioned plan and elevations of equipment racks, control panels, and consoles. Show access and workspace requirements.
4. UPS: Sizing calculations.
5. Wiring Diagrams: For power, signal, and control wiring.

C. Design Data: Include an equipment list consisting of every piece of equipment by model number, manufacturer, serial number, location, and date of original installation. Add pretesting record of each piece of equipment, listing name of person testing, date of test, set points of adjustments, name and description of the view of preset positions, description of alarms, and description of unit output responses to an alarm.

D. Seismic Qualification Data: Certificates, for cameras, camera-supporting equipment, accessories, and components, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Product Warranty: Sample of special warranty.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For cameras, power supplies, infrared illuminators, monitors, videotape recorders, digital video recorders, video switches, and control-station

components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Lists of spare parts and replacement components recommended to be stored at the site for ready access.

1.4 PROJECT CONDITIONS

A. Environmental Conditions: Capable of withstanding the Gig Harbor environmental conditions without mechanical or electrical damage or degradation of operating capability.

1.5 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of cameras, equipment related to camera operation, and control-station equipment that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Three years from date of Substantial Completion.

1.6 CAMERA SCHEDULE

NUMBER	LOCATION	INT/EXT	CABLE	MANUFACTURE		MOUNT	APP HEIGHT
1	ENTRY DOOR	EXT	UTP	AXIS	P3245	SOFFIT	SOFFIT
2	WEST BUILDING NORTH	EXT	UTP	AXIS	P3717	WALL	12'
3	NW BUILDING SIDE	EXT	UTP	AXIS	P3717	WALL	12'
4	NE BUILDING SIDE	EXT	UTP	AXIS	P3717	WALL	12'
5	EAST BUILDING NORTH	EXT	UTP	AXIS	P3717	WALL	12'
6	LOADING DOOR	EXT	UTP	AXIS	P3225	WALL	9'
7	EAST COURTYARD	EXT	UTP	AXIS	P3717	WALL	9'
8	EAST BUILDING SOUTH	EXT	UTP	AXIS	P3717	WALL	12'
9	SOUTH BUILDING EAST	EXT	UTP	AXIS	P3717	WALL	12'
10	STUDENT ENTRY DOOR	EXT	UTP	AXIS	P3717	SOFFIT	SOFFIT
11	SOUTH BUILDING WEST	EXT	UTP	AXIS	P3717	WALL	12'
12	WEST BUILDING SOUTH	EXT	UTP	AXIS	P3717	WALL	12'
13	LOBBY SOUTH	INT	UTP	AXIS	P3717	CLG	CLG
14	LOBBY NORTH	INT	UTP	AXIS	P3717	CLG	CLG
15	SOUTH CORRIDOR LOWER	INT	UTP	AXIS	P3717	CLG	CLG
16	SE ENTRY STAIR	INT	UTP	AXIS	P3717	WALL	12'
17	PLATFORM	INT	UTP	AXIS	P3717	WALL	12'
18	BACKSTAGE STORAGE	INT	UTP	AXIS	P3717	CORNER	10'
19	CONCERT HALL SOUTH	INT	UTP	AXIS	P3717	WALL	12'
20	CONCERT HALL NORTH	INT	UTP	AXIS	P3717	WALL	12'

21	MAIN LOBBY STAIR	INT	UTP	AXIS	P3717	WALL	12'
22	SECOND NORTH CORRIDOR	INT	UTP	AXIS	P3717	WALL	12'
23	SOUTH CORRIDOR UPPER	INT	UTP	AXIS	P3717	CLG	CLG
24	ENTRY DRIVE	EXT	UTP	AXIS	P3717	POLE	12'
25	WEST PARKING	EXT	UTP	AXIS	P3717	POLE	12'
26	NORTH PARKING - W	EXT	UTP	AXIS	P3717	POLE	12'
27	NORTH PARKING - E	EXT	UTP	AXIS	P3717	POLE	12'
28	EAST DRIVE	EXT	UTP	AXIS	P3717	POLE	12'
29	EAST PARKING	EXT	UTP	AXIS	P3717	POLE	12'

PART 2 PRODUCTS

2.1 SYSTEM REQUIREMENTS

A. Fully IP/POE security camera system. Manufacturer is Axis cameras with Genetec software.

B. Software will be expanded on the district’s existing video surveillance server

C. Licenses will be provided for all devices.

D. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor's entry connection to components.
   1. Minimum Protection for Power Connections 120 V and More: Auxiliary panel suppressors complying with requirements in Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."
   2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Connections: Comply with requirements in Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits" as recommended by manufacturer for type of line being protected.

E. Tamper Protection: Tamper switches on enclosures, control units, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal when unit is opened or partially disassembled. Control-station, control-unit alarm display shall identify tamper alarms and indicate locations.

2.2 FIXED ZOOM DOME CAMERAS

A. Axis P3245-LVE
   1. Image sensor 1/2.8”progressivescanRGBCMOS
   2. Lens Varifocal, 3.4–8.9 mm, F1.8
      a. Horizontal field of view: 100°–36°
      b. Vertical field of view: 53°–20°
      c. Remote focus and zoom, P-Iris control, IR corrected
   3. Day and night Automatically removable infrared-cut filter
   4. Minimum illumination
      a. HDTV 1080p 25/30 fps with WDR - forensic capture and Lightfinder:

b. Color: 0.16 lux at 50 IRE, F1.4
c. B/W: 0.03 lux at 50 IRE, F1.4, 0 lux with IR illumination on
d. HDTV 1080p 50/60 fps:
e. Color: 0.32 lux at 50 IRE, F1.4
f. B/W: 0.06 lux at 50 IRE, F1.4, 0 lux with IR illumination on

5. Shutter time 1/66500 s to 1 s
6. Camera angle adjustment
   a. Pan ±180°, tilt -35 to +75°, rotation ±95°
7. Video compression
   a. H.264 Baseline, Main and High Profile (MPEG-4 Part 10/AVC)
   b. Motion JPEG
8. Resolution 1920x1080 to 160x90
9. Frame rate
   a. With WDR: 25/30 fps with power line frequency 50/60 Hz
   b. Without WDR: 50/60 fps with power line frequency 50/60 Hz
10. Video streaming
    a. Multiple, individually configurable streams in H.264 and Motion JPEG
    b. Axis Zipstream technology in H.264
    c. Controllable frame rate and bandwidth
    d. VBR/ABR/MBR H.264
11. Multi-view streaming: 2 individually cropped out view areas
12. Pan/Tilt/Zoom: Digital PTZ, preset positions
13. Image settings
    a. Compression, Color, Brightness, Sharpness, Contrast, Local contrast, White balance, Exposure control (including automatic gain control), Exposure zones, Fine tuning of behavior at low light, WDR - forensic capture: Up to 120 dB depending on scene, Text and image overlay, Mirroring of images, Privacy masks
    b. Rotation: 0°, 90°, 180°, 270°, including Corridor Format
14. Security
    a. Password protection, IP address filtering, HTTPSa encryption, IEEE 802.1x (EAP-TLS)a network access control, Digest authentication, User access log, Centralized Certificate Management, brute force delay protection, signed firmware
15. Supported protocols
    a. IPv4, IPv6 USGv6, HTTP, HTTPSa, SSL/TLSa, QoS Layer 3 DiffServ,
    b. FTP, CIFS/SMB, SMTP, Bonjour, UPnPTM, SNMP v1/v2c/v3(MIB-II),
    c. DNS, DynDNS, NTP, RTSP, RTP, SRTP, SFTP, TCP, UDP, IGMP, RTCP,
    d. ICMP, DHCP, ARP, SOCKS, SSH, LLDP
16. Application Programming Interface
    a. Open API for software integration, including VAPIX® and
    b. AXIS Camera Application Platform; specifications at axis.com
    c. AXIS Guardian with One-Click Connection
    d. ONVIF® Profile G, ONVIF® Profile S, and ONVIF® Profile T, specification at onvif.org
17. Analytics Included
    a. AXIS Video Motion Detection, active tampering alarm
    b. Supported
       1) AXIS Motion Guard, AXIS Fence Guard, AXIS Loitering Guard,
       2) AXIS Perimeter Defender
    c. AXIS Digital Autotracking, AXIS People Counter,
    d. AXIS Tailgating Detector, AXIS Direction Detector,
    e. AXIS Occupancy Estimator, AXIS Random Inspection,
    f. AXIS Queue Monitor

g. Support for AXIS Camera Application Platform enabling installation of third-party applications, see axis.com/acap
18. Event triggers: Analytics, edge storage events, virtual inputs through API
19. Event actions
    a. Record video: SD card and network share
    b. Upload of images or video clips: FTP, SFTP, HTTP, HTTPS, network share and email
    c. Pre- and post-alarm video or image buffering for recording or upload
    d. Notification: email, HTTP, HTTPS, TCP and SNMP trap Overlay text
20. Data streaming: Event data
21. Built-in installation aids: Remote zoom, remote focus, pixel counter, optimized IR with adjustable IR illumination intensity
22. Casing
    a. IP66- and NEMA 4X-rated, IK10 impact-resistant casing with hard-coated dome and dehumidifying membrane
    b. Encapsulated electronics and captive screws
    c. Color: white NCS S 1002-B
23. Mounting
    a. Mounting bracket with holes for junction boxes (double-gang,single-gang, and 4" octagon) and for wall or ceiling mount
    b. ¼"-20 UNC tripod screw thread
24. Sustainability PVC free
25. Memory 512 MB RAM, 256 MB Flash
26. Power over Ethernet IEEE 802.3af/802.3at Type 1 Class 3, max 10.8 W, typical 7.3 W
27. Connectors Shielded RJ45 10BASE-T/100BASE-TX PoE
28. IR illumination Optimized IR with power-efficient, long-life 850 nm IR LEDs with adjustable illumination intensity. Range of reach 30 m (100 ft) or more depending on scene
29. Storage
    a. Support for microSD/microSDHC/microSDXC card
    b. Support for SD card encryption
    c. Support for recording to network-attached storage (NAS)
30. Approvals
    a. EMC
    b. EN 55022 Class B, EN 61000-6-1, EN 61000-6-2, EN 55024,
    c. EN 50121-4, IEC 62236-4, FCC Part 15 Subpart B Class A and B,
    d. ICES-003 Class B, VCCI Class B, RCM AS/NZS CISPR 22 Class B,
    e. KCC KN22 Class B, KN24
31. Safety
    a. IEC/EN/UL 60950-1, IEC/EN/UL 60950-22, IEC/EN 62471,
    b. IS 13252
32. Environment
    a. IEC 60068-2-1, IEC 60068-2-2, IEC 60068-2-14
    b. IEC 60068-2-6 (vibration), IEC 60068-2-27 (shock),
    c. IEC 60068-2-30, IEC 60068-2-78, IEC/EN 60529 IP66,
    d. NEMA 250 Type 4X, IEC/EN 62262 IK10
33. Network
    1) NIST SP500-267
34. Video management software
    a. AXIS Companion, AXIS Camera Station, Video management software from Axis' Application Development Partners available on axis.com/vms
35. Accessories as required
36. Warranty Axis 3-year warranty and AXIS Extended Warranty

2.3 MULTISENSOR 360 DEGREE CAMERA

A. Axis P3717-PLE
1. Image sensor
   a. 4 x 1/2.8” progressive scan RGB CMOS
2. Lens
   a. Varifocal, 3–6 mm, F1.8–2.6
   b. Horizontal field of view: 96°–49°
   c. Vertical field of view: 53°–27°
   d. Diagonal field of view: 113°–55°
   e. Motorized focus, motorized zoomDay and night Automatically removable infrared-cut filter
3. Day and Night
   a. Automatically removable infrared-cut filter
4. Minimum illumination
   a. Color: 0.17 lux at 50 IRE F1.8
   b. B/W: 0.04 lux at 50 IRE F1.8, 0 lux with IR illumination on
5. Shutter time
   a. 1/32500 s to 2 s with 60 Hz
6. Camera angle adjustment
   a. Pan ±90°, tilt +25 to +95°, rotation –5 to +95°, twist ±20°
7. Video compression
   a. H.264 Baseline, Main and High Profile (MPEG-4 Part 10/AVC)
   b. Motion JPEG
8. Resolution
   a. 4 x 1920x1080 (4 x HDTV 1080p) to 160x90
9. Frame rate
   a. Up to 25/30 fps (50/60 Hz)
   b.
10. Video streaming
   a. Multiple, individually configurable streams in H.264 and Motion JPEG
   b. Axis Zipstream technology in H.264
   c. Controllable frame rate and bandwidth
   d. VBR/ABR/MBR H.264
11. Image settings
   a. Saturation, contrast, brightness, sharpness, Forensic WDR, white balance, exposure control, exposure zone, fine tuning of behavior at low light, rotation: 0°, 90°, 180°, 270° including Corridor Format, dynamic text and image overlay, Polygon privacy mask, compression
12. IP Address: 1 for all channels
13. Security
   a. Password protection, IP address filtering, HTTPSa encryption, IEEE 802.1x (EAP-TLS)a network access control, Digest authentication, User access log, Centralized Certificate Management, brute force delay protection, signed firmware
14. Supported protocols
   a. IPv4/v6, HTTP, HTTPSa, SSL/TLSa, QoS Layer 3 DiffServ, FTP,
   b. CIFS/SMB, SMTP, Bonjour, UPnPTM, SNMP v1/v2c/v3 (MIB-II),
   c. DNS, DynDNS, NTP, RTSP, RTP, SFTP, TCP, UDP, IGMP, RTCP, ICMP,
   d. DHCP, ARP, SOCKS, SSH
15. Application Programming Interface
   a. Open API for software integration, including VAPIX® and
   b. AXIS Camera Application Platform; specifications at axis.com
   c. AXIS Guardian with One-Click Connection

d. ONVIF® Profile G and ONVIF® Profile S, specification at onvif.Analytics Included
e.

16. Analytics
    a. AXIS Video Motion Detection, active tampering alarm
    b. Supported
        1) AXIS Perimeter Defenderb, AXIS Guard Suite including AXIS Motion Guard, AXIS Fence Guard, and AXIS Loitering Guard
        2) Support for AXIS Camera Application Platform enabling installation of third-party applications, see axis.com/acap
17. Event triggers: Detectors, hardware, input signal, storage, system, time, analytics, edge storage events
18. Event actions
    a. Day/night vision mode, overlay text, record video, send images, send notification, send SNMP trap, send video clip, status LED
    b. File upload: FTP, HTTP, HTTPS, network share, SFTP and email
    c. Notification: email, HTTP, HTTPS, TCP and SNMP trap
19. Data streaming: Event data
20. Built-in installation aids: Pixel counter, focus assistant, remote focus, remote zoom
21. Casing
    a. IP66-, IP67-, NEMA 4X-rated, IK09 impact-resistant, aluminium and plastic casing with polycarbonate hard-coated dome,sunshield (PC/ASA)
    b. Color: white NCS S 1002-B
22. Mounting
    a. Mounting bracket with junction box holes (double gang box, single gang box, 4” octagon junction box and 4” square junction box)
    b. ½” (M20) conduit side entry
    c. ¾” (M25) conduit adapter included
23. Sustainability PVC free
24. Memory 1024 MB RAM, 512 MB Flash
25. Power over Ethernet:
    a. Power over Ethernet (PoE) IEEE 802.3at Type 2 Class 4
    b. IR illumination on: class 4, typical 11.1 W, max 17.0 W
    c. IR illumination off: class 3, typical 8.6 W, max 11.0 W
26. Connectors
    a. Shielded RJ45 10BASE-T/100BASE-TX PoE
    b. Audio and I/O connectivity via AXIS T61 Audio and I/O Interfaces with portcast technology
27. IR illumination
    a. Optimized IR with power-efficient, long-life 850 nm IR LEDs with adjustable illumination intensity. Range of reach 30 m (100 ft) or more depending on scene
28. Storage
    a. Support for microSD/microSDHC/microSDXC card
    b. Dual SD cards
    c. Support for SD card encryption
    d. Support for recording to network-attached storage (NAS)
29. Approvals
    a. EMC
    b. EN 55022 Class B, EN 61000-6-1, EN 61000-6-2, EN 55024,
    c. EN 50121-4, IEC 62236-4, FCC Part 15 Subpart B Class A and B,
    d. ICES-003 Class B, VCCI Class B, RCM AS/NZS CISPR 22 Class B,
    e. KCC KN22 Class B, KN24
30. Safety
    a. IEC/EN/UL 60950-1, IEC/EN/UL 60950-22, IEC/EN 62471,
    b. IS 13252

31. Environment
    a. IEC 60068-2-1, IEC 60068-2-2, IEC 60068-2-14
    b. IEC 60068-2-6 (vibration), IEC 60068-2-27 (shock),
    c. IEC 60068-2-30, IEC 60068-2-78, IEC/EN 60529 IP66,
    d. NEMA 250 Type 4X, IEC/EN 62262 IK10
32. Network
    1) NIST SP500-267
33. Video management software
    a. AXIS Companion, AXIS Camera Station, Video management software from Axis' Application Development Partners available on axis.com/vms
34. Accessories as required
35. Warranty Axis 3-year warranty and AXIS Extended Warranty

2.4 POWER SUPPLIES

A. POE, inside building

B. When over 295 feet provide Vigitron Range Extender VI2300W on each end.
    1. Enclosure: NEMA 250 Type 4X

2.5 GENETEC SOFTWARE

A. Install Genetec software on district server for all new cameras

B. Include licenses for 3 years for all cameras

C. Update all firmware on cameras prior to substantial completion

2.6 CABLING

A. Cable: IP, all cable provided in 271500

2.7 SWITCHES
    1. Data switches will be provided by the owner. Contractor shall direct owner in setup of switches to allow for complete operation of the system

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for LAN, WAN, and IP network before device installation.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 WIRING

A. By 271500 contractor

3.3 VIDEO SURVEILLANCE SYSTEM INSTALLATION

A. Install cameras and infrared illuminators level and plumb.

B. Install cameras with 84-inch- (2134-mm-) minimum clear space below cameras and their mountings. Change type of mounting to achieve required clearance.

C. Install and aim camera per owner direction. Owner will be on site during camera aim and final set

D. Set video standards, compression, frame rates per owner requirements.

E. Set motion alerts, recording per owner requirements.

F. Install auxiliary components.

G. Install tamper switches on components indicated to receive tamper switches, arranged to detect unauthorized entry into system-component enclosures and mounted in self-protected, inconspicuous positions.

H. Camera Mounting Hights

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Tests and Inspections:
   1. Inspection: Verify that units and controls are properly installed, connected, and labeled, and that interconnecting wires and terminals are identified.
   2. Pretesting: Align and adjust system and pretest components, wiring, and functions to verify that they comply with specified requirements. Conduct tests at varying lighting levels, including day and night scenes as applicable. Prepare video-surveillance equipment for acceptance and operational testing as follows:
      a. Prepare equipment list described in "Informational Submittals" Article.
      b. Verify operation of auto-iris lenses.
      c. Set back-focus of fixed focal length lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Adjust until image is in focus with and without the filter.
      d. Set back-focus of zoom lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Additionally, set zoom to full wide angle and aim camera at an object 50 to 75 feet (17 to 23 m) away. Adjust until image is in focus from full wide angle to full telephoto, with the filter in place.
      e. Set and name all preset positions; consult Owner's personnel.
      f. Set sensitivity of motion detection.
      g. Connect and verify responses to alarms.
      h. Verify operation of control-station equipment.
   3. Test Schedule: Schedule tests after pretesting has been successfully completed and system has been in normal functional operation for at least 14 days. Provide a minimum of 10 days' notice of test schedule.
   4. Operational Tests: Perform operational system tests to verify that system complies with Specifications. Include all modes of system operation. Test equipment for proper operation in all functional modes.

C. Video surveillance system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.5 ADJUSTING

A. Occupancy Adjustments: When requested within 12months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose. Tasks shall include, but are not limited to, the following:
   1. Check cable connections.
   2. Check proper operation of cameras and lenses. Verify operation of auto-iris lenses and adjust back-focus as needed.
   3. Adjust all preset positions; consult Owner's personnel.
   4. Recommend changes to cameras, lenses, and associated equipment to improve Owner's use of video surveillance system.
   5. Provide a written report of adjustments and recommendations.

3.6 CLEANING

A. Clean installed items using methods and materials recommended in writing by manufacturer.

B. Clean video-surveillance-system components, including camera-housing windows, lenses, and monitor screens.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain video-surveillance equipment. Provide 8 hours of training in 2 sessions. Record all sessions and deliver to owner

END OF SECTION

PART 1 - GENERAL

1.1 DESCRIPTION:

A. This section of the specification includes the furnishing, installation, connection and testing of the microprocessor controlled, intelligent reporting fire alarm equipment required to form a complete, operative, coordinated system with voice alarm. It shall include, but not be limited to, alarm initiating devices, alarm notification appliances, Fire Alarm Control Panel (FACP), auxiliary control devices, annunciators, and wiring as shown on the drawings and specified herein.

B. The existing Simplex panel on the campus shall remain and the new panel shall network to the panel. Provide all upgrades to the existing panel required. The existing campus is not voice alarm. The new building is fully voice alarm and shall be capable of functioning in stand alone mode.

C. Provide a remote voice station at the front entry

D. The fire alarm system shall comply with requirements of NFPA Standard 72 for Protected Premises Signaling Systems except as modified and supplemented by this specification. The system shall be electrically supervised and monitor the integrity of all conductors.

E. The fire alarm system shall be manufactured by an ISO 9001 certified company and meet the requirements of BS EN9001: ANSI/ASQC Q9001-1994.

F. The FACP and peripheral devices shall be manufactured 100% by a single U.S. manufacturer (or division thereof).

G. The system and its components shall be Underwriters Laboratories, Inc. listed under the appropriate UL testing standard as listed herein for fire alarm applications and the installation shall be in compliance with the UL listing.

H. The installing company shall employ NICET (minimum Level II Fire Alarm Technology) technicians on site to guide the final checkout and to ensure the systems integrity.

I. Installer shall be a NESCO affiliate

1.2 SCOPE:

A. A new intelligent reporting, microprocessor controlled fire detection system shall be installed in accordance to the project specifications and drawings.

B. Basic Performance:

1. Alarm, trouble and supervisory signals from all intelligent reporting devices shall be encoded on NFPA Style 4 (Class B) Signaling Line Circuits (SLC).
2. Initiation Device Circuits (IDC) shall be wired Class A (NFPA Style D) as part of an addressable device connected by the SLC Circuit.

3. Notification Appliance Circuits (NAC) shall be wired Class A (NFPA Style Z) as part of an addressable device connected by the SLC Circuit.
4. On Style 6 or 7 (Class A) configurations a single ground fault or open circuit on the system Signaling Line Circuit shall not cause system malfunction, loss of operating power or the ability to report an alarm.
5. Alarm signals arriving at the FACP shall not be lost following a primary power failure (or outage) until the alarm signal is processed and recorded.
6. NAC speaker circuits shall be arranged such that there is a minimum of one speaker circuit per floor of the building or smoke zone whichever is greater.
7. Audio amplifiers and tone generating equipment shall be electrically supervised for normal and abnormal conditions.
8. NAC speaker circuits and control equipment shall be arranged such that loss of any one (1) speaker circuit will not cause the loss of any other speaker circuit in the system.
9. Two-way telephone communication circuits shall be supervised for open and short circuit conditions.

C. BASIC SYSTEM FUNCTIONAL OPERATION

D. When a fire alarm condition is detected and reported by one of the system initiating devices, the following functions shall immediately occur:

1. The system alarm LED on the system display shall flash.
2. A local piezo electric signal in the control panel shall sound.
3. A backlit LCD display shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.
4. Printing and history storage equipment shall log the information associated each new fire alarm control panel condition, along with time and date of occurrence.
5. All system output programs assigned via control-by-event interlock programming to be activated by the particular point in alarm shall be executed, and the associated system outputs (notification appliances and/or relays) shall be activated.

1.3 SUBMITTALS

A. General:

1. Two copies of all submittals shall be submitted to the Architect/Engineer for review.
2. All references to manufacturer's model numbers and other pertinent information herein is intended to establish minimum standards of performance, function and quality. Equivalent compatible UL-listed equipment from other manufacturers may be substituted for the specified equipment as long as the minimum standards are met.
3. For equipment other than that specified, the contractor shall supply proof that such substitute equipment equals or exceeds the features, functions, performance, and quality of the specified equipment.

B. Shop Drawings:

1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
2. Include manufacturer's name(s), model numbers, ratings, power requirements, equipment layout, device arrangement, complete wiring point-to-point diagrams, and conduit layouts.
3. Show annunciator layout, configurations, and terminations.

C. Manuals:

1. Submit simultaneously with the shop drawings, complete operating and maintenance manuals listing the manufacturer's name(s), including technical data sheets.
2. Wiring diagrams shall indicate internal wiring for each device and the interconnections between the items of equipment.
3. Provide a clear and concise description of operation that gives, in detail, the information required to properly operate the equipment and system.

D. Software Modifications

1. Provide the services of a factory trained and authorized technician to perform all system software modifications, upgrades or changes. Response time of the technician to the site shall not exceed 4 hours.
2. Provide all hardware, software, programming tools and documentation necessary to modify the fire alarm system on site. Modification includes addition and deletion of devices, circuits, zones and changes to system operation and custom label changes for devices or zones. The system structure and software shall place no limit on the type or extent of software modifications on-site.

E. Certifications:

F. Together with the shop drawing submittal, submit a certification from the major equipment manufacturer indicating that the proposed supervisor of the installation and the proposed performer of contract maintenance is an authorized representative of the major equipment manufacturer. Include names and addresses in the certification.

1.4 GUARANTY:

A. All work performed and all material and equipment furnished under this contract shall be free from defects and shall remain so for a period of at least one (1) year from the date of acceptance. The full cost of maintenance, labor and materials required to correct any defect during this one year period shall be included in the submittal bid.

1.5 POST CONTRACT MAINTENANCE:

A. Complete maintenance and repair service for the fire alarm system shall be available from a factory trained authorized representative of the manufacturer of the major equipment for a period of five (5) years after expiration of the guaranty.

B. As part of the bid/proposal, include a quote for a maintenance contract to provide all maintenance, tests, and repairs described below. Include also a quote for unscheduled maintenance/repairs, including hourly rates for technicians trained on this equipment, and response travel costs for each year of the maintenance period. Submittals that do not identify all post contract maintenance costs will not be accepted. Rates and costs shall be valid for the period of five (5) years after expiration of the guaranty.

C. Maintenance and testing shall be on a semiannual basis or as required by the AHJ. A preventive maintenance schedule shall be provided by the contractor describing the protocol for preventive maintenance. The schedule shall include:

1. Systematic examination, adjustment and cleaning of all detectors, manual fire alarm stations, control panels, power supplies, relays, waterflow switches and all accessories of the fire alarm system.
2. Each circuit in the fire alarm system shall be tested semiannually.
3. Each smoke detector shall be tested in accordance with the requirements of NFPA 72 Chapter 7.

1.6 APPLICABLE STANDARDS AND SPECIFICATIONS:

A. The specifications and standards listed below form a part of this specification. The system shall fully comply with the latest issue of these standards, if applicable.

B. National Fire Protection Association (NFPA) - USA:

1.	No. 12	CO_2 Extinguishing Systems (low and high)
2.	No. 12B	Halon 1211 Extinguishing Systems
3.	No. 13	Sprinkler Systems
4.	No. 13A	Halon 1301 Extinguishing Systems
5.	No. 15	Water Spray Systems
6.	No. 16	Foam/Water Deluge and Spray Systems
7.	No. 17	Dry Chemical Extinguishing Systems
8.	No. 17A	Wet Chemical Extinguishing Systems
9.	No. 2001	Clean Agent Extinguishing Systems
10.	No. 72	National Fire Alarm Code
11.	No. 101	Life Safety Code

C. Underwriters Laboratories Inc. (UL) - USA:

1.	No. 268	Smoke Detectors for Fire Protective Signaling Systems
2.	No. 864	Control Units for Fire Protective Signaling Systems
3.	No. 268A	Smoke Detectors for Duct Applications
4.	No. 521	Heat Detectors for Fire Protective Signaling Systems
5.	No. 464	Audible Signaling Appliances
6.	No. 38	Manually Actuated Signaling Boxes
7.	No. 346	Waterflow Indicators for Fire Protective Signaling Systems
8.	No. 1076	Control Units for Burglar Alarm Proprietary Protective Signaling Systems
9.	No. 1971	Visual Notification Appliances
10.	No. 217	217 Smoke Detectors, Single and Multiple Station
11.	N0. 228	Door Closers - Holders for Fire Protective Signaling Systems
12.	No. 1481	Power Supplies for Fire Protective Signaling Systems
13.	No. 60951	Safety of Information Technology Equipment

D. Local and State Building Codes.

E. All requirements of the Authority Having Jurisdiction (AHJ).

1.7 APPROVALS:

A. The system shall have proper listing and/or approval from the following nationally recognized agencies:

1. UL — Underwriters Laboratories Inc
2. ULC — Underwriters Laboratories Canada

B. The fire alarm control panel shall meet UL Standard 864 Ninth Edition (Control Units) and UL Standard 1076 (Proprietary Burglar Alarm Systems).

C. The system shall be listed by the national agencies as suitable for extinguishing release applications. The system shall support release of high and low pressure CO2.

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIAL, GENERAL:

A. All equipment and components shall be new, and the manufacturer's current model. The materials, appliances, equipment and devices shall be tested and listed by a nationally recognized approvals agency for use as part of a protective signaling system, meeting the National Fire Alarm Code.

B. All equipment and components shall be installed in strict compliance with manufacturers' recommendations. Consult the manufacturer's installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc., before beginning system installation.

C. All equipment shall be attached to walls and ceiling/floor assemblies and shall be held firmly in place (e.g., detectors shall not be supported solely by suspended ceilings). Fasteners and supports shall be adequate to support the required load.

2.2 CONDUIT AND WIRE:

A. Conduit:

1. Conduit shall be in accordance with The National Electrical Code (NEC), local and state requirements.
2. Where required, all wiring shall be installed in conduit or raceway. Conduit fill shall not exceed 40 percent of interior cross sectional area where three or more cables are contained within a single conduit.
3. Cable must be separated from any open conductors of power, or Class 1 circuits, and shall not be placed in any conduit, junction box or raceway containing these conductors, per NEC Article 760.
4. Wiring for 24 volt DC control, alarm notification, emergency communication and similar power-limited auxiliary functions may be run in the same conduit as initiating and signaling line circuits. All circuits shall be provided with transient suppression devices and the system shall be designed to permit simultaneous operation of all circuits without interference or loss of signals.
5. Conduit shall not enter the fire alarm control panel, or any other remotely mounted control panel equipment or backboxes, except where conduit entry is specified by the FACP manufacturer.
6. Conduit shall be 3/4-inch (19.1 mm) minimum.

B. Wire:

1. All fire alarm system wiring shall be new.
2. Wiring shall be in accordance with local, state and national codes (e.g., NEC Article 760) and as recommended by the manufacturer of the fire alarm system. Number and size of conductors shall be as recommended by the fire alarm system manufacturer, but not less than 18 AWG (1.02 mm) for Initiating Device Circuits, Signaling Line Circuits, and Notification Appliance Circuits.
3. All wire and cable shall be listed and/or approved by a recognized testing agency for use with a protective signaling system.
4. Wire and cable not installed in conduit shall have a fire resistance rating suitable for the installation as indicated in NFPA 70 (e.g., FPLR).
5. Wiring used for the multiplex communication circuit (SLC) shall be twisted and unshielded and support a minimum wiring distance of 12,500 feet. The design of the system shall permit use of IDC and NAC wiring in the same conduit with the SLC communication circuit.
6. All field wiring shall be electrically supervised for open circuit and ground fault.
7. The fire alarm control panel shall be capable of t-tapping Class B (NFPA Style 4) Signaling Line Circuits (SLCs). Systems that do not allow or have restrictions in, for example, the amount of t-taps, length of t-taps etc., are not acceptable.

C. Terminal Boxes, Junction Boxes and Cabinets:

1. All boxes and cabinets shall be UL listed for their use and purpose.

D. Initiating circuits shall be arranged to serve like categories (manual, smoke, waterflow). Mixed category circuitry shall not be permitted except on signaling line circuits connected to intelligent reporting devices.

E. The fire alarm control panel shall be connected to a separate dedicated branch circuit, maximum 20 amperes. This circuit shall be labeled at the main power distribution panel as FIRE ALARM. Fire alarm control panel primary power wiring shall be 12 AWG. The control panel cabinet shall be grounded securely to either a cold water pipe or grounding rod.

2.3 MAIN FIRE ALARM CONTROL PANEL

A. Main FACP or network node shall be a Simplex 4100ES with voice alarm and shall contain a microprocessor based Central Processing Unit (CPU) and power supply in an economical space saving single board design. The CPU shall communicate with and control the following types of equipment used to make up the system: intelligent addressable smoke and thermal (heat) detectors, addressable modules, printer, annunciators, and other system controlled devices.

B. Operator Control

1. Acknowledge Switch:

a. Activation of the control panel acknowledge switch in response to new alarms and/or troubles shall silence the local panel piezo electric signal and change the alarm and trouble LEDs from flashing mode to steady-ON mode. If multiple alarm or trouble conditions exist, depression of this switch shall advance the LCD display to the next alarm or trouble condition.
b. Depression of the Acknowledge switch shall also silence all remote annunciator piezo sounders.

2. Alarm Silence Switch:

    a. Activation of the alarm silence switch shall cause all programmed alarm notification appliances and relays to return to the normal condition after an alarm condition. The selection of notification circuits and relays that are silenceable by this switch shall be fully field programmable within the confines of all applicable standards. The FACP software shall include silence inhibit and auto-silence timers.

3. Alarm Activate (Drill) Switch:

    a. The Alarm Activate switch shall activate all notification appliance circuits. The drill function shall latch until the panel is silenced or reset.

4. System Reset Switch:

    a. Activation of the System Reset switch shall cause all electronically-latched initiating devices, appliances or software zones, as well as all associated output devices and circuits, to return to their normal condition.

5. Lamp Test:

    a. The Lamp Test switch shall activate all local system LEDs, light each segment of the liquid crystal display and display the panel software revision for service personal

C. System Capacity and General Operation

1. The control panel or each network node shall provide, or be capable of expansion to 636 intelligent/addressable devices.
2. The control panel or each network node shall include Form-C alarm, trouble, supervisory, and security relays rated at a minimum of 2.0 amps @ 30 VDC.
3. It shall also include four Class B (NFPA Style Y) or Class A (NFPA Style Z) programmable Notification Appliance Circuits
4. The Notification Appliance Circuits shall be programmable to Synchronize with System Sensor, Gentex and Wheelock Notification Appliances.
5. The system shall include a full featured operator interface control and annunciation panel that shall include a backlit Liquid Crystal Display (LCD), individual color coded system status LEDs, and an alphanumeric keypad with easy touch rubber keys for the field programming and control of the fire alarm system.
6. The system shall be programmable, configurable, and expandable in the field without the need for special tools, PROM programmers or PC based programmers. It shall not require replacement of memory ICs to facilitate programming changes.
7. The system shall allow the programming of any input to activate any output or group of outputs. Systems that have limited programming (such as general alarm), have complicated programming (such as a diode matrix), or require a laptop personal computer are not considered suitable substitutes.
8. The FACP shall support up to 20 logic equations, including "and," "or," and "not," or time delay equations to be used for advanced programming. Logic equations shall require the use of a PC with a software utility designed for programming.
9. The FACP or each network node shall provide the following features:

    a. Drift compensation to extend detector accuracy over life. Drift compensation shall also include a smoothing feature, allowing transient noise signals to be filtered out.
    b. Detector sensitivity test, meeting requirements of NFPA 72.

c. Maintenance alert, with two levels (maintenance alert/maintenance urgent), to warn of excessive smoke detector dirt or dust accumulation.
d. Nine sensitivity levels for alarm, selected by detector. The alarm level range shall be .5 to 2.35 percent per foot for photoelectric detectors and 0.5 to 2.5 percent per foot for ionization detectors. The system shall also support sensitive advanced detection laser detectors with an alarm level range of .02 percent per foot to 2.0 percent per foot. The system shall also include up to nine levels of Prealarm, selected by detector, to indicate impending alarms to maintenance personnel.
e. The ability to display or print system reports.
f. Alarm verification, with counters and a trouble indication to alert maintenance personnel when a detector enters verification 20 times.
g. PAS presignal, meeting NFPA 72 requirements.
h. Rapid manual station reporting (under 3 seconds) and shall meet NFPA 72 requirements for activation of notification circuits within 10 seconds of initiating device activation.
i. Periodic detector test, conducted automatically by the software.
j. Self optimizing pre-alarm for advanced fire warning, which allows each detector to learn its particular environment and set its prealarm level to just above normal peaks.
k. Cross zoning with the capability of counting: two detectors in alarm, two software zones in alarm, or one smoke detector and one thermal detector.
l. Walk test, with a check for two detectors set to same address.
m. Control-by-time for non-fire operations, with holiday schedules.
n. Day/night automatic adjustment of detector sensitivity.
o. Device blink control for sleeping areas.

10. The FACP shall be capable of coding main panel node notification circuits in March Time (120 PPM), Temporal (NFPA 72), and California Code. Panel notification circuits (NAC 1, 2, 3 and 4) shall also support Two-Stage operation, Canadian Dual Stage (3 minutes) and Canadian Dual Stage (5 minutes). Two stage operation shall allow 20 Pulses Per Minute (PPM) on alarm and 120 PPM after 5 minutes or when a second device activates. Canadian Dual stage is the same as Two-Stage except will only switch to second stage by activation of Drill Switch 3 or 5 minute timer. The panel shall also provide a coding option that will synchronize specific strobe lights designed to accept a specific "sync pulse."
11. Network Communication

    a. The FACP shall be capable of communicating on a Local Area Network (LAN), a firmware package that utilizes a peer-to-peer, inherently regenerative communication format and protocol.

D. Central Microprocessor

1. The microprocessor shall be a state-of-the-art, high speed, 16-bit RISC device and it shall communicate with, monitor and control all external interfaces. It shall include an EPROM for system program storage, Flash memory for building-specific program storage, and a "watch dog" timer circuit to detect and report microprocessor failure.
2. The microprocessor shall contain and execute all control-by-event programs for specific action to be taken if an alarm condition is detected by the system. Control-by-event equations shall be held in non-volatile programmable memory, and shall not be lost even if system primary and secondary power failure occurs.
3. The microprocessor shall also provide a real-time clock for time annotation of system displays, printer, and history file. The time-of-day and date shall not be lost if system

primary and secondary power supplies fail. The real time clock may also be used to control non-fire functions at programmed time-of-day, day-of-week, and day-of-year.

4. A special program check function shall be provided to detect common operator errors.
5. An auto-program (self-learn) function shall be provided to quickly install initial functions and make the system operational.
6. For flexibility and to ensure program validity, an optional Windows(TM) based program utility shall be available. This program shall be used to off-line program the system with batch upload/download, and have the ability to upgrade the manufacturers (FLASH) system code changes. This program shall also have a verification utility, which scans the program files, identifying possible errors. It shall also have the ability to compare old program files to new ones, identifying differences in the two files to allow complete testing of any system operating changes. This shall be in incompliance with the NFPA 72 requirements for testing after system modification.

E. System Display

1. The system shall support the following display mode options:

   a. The CPU with no display option shall allow the fire alarm control panel to function as a data-gathering panel when the panel is connected to a network with a Network Control Station (NCS), ONYXWorks workstation or Network Control Annunciator (NCA). In this application, the NCS, OW or NCA shall provide all of the necessary controls and indicators to be used by the system operator. Programming of the CPU may be accomplished from the NCS or by use of a laptop PC with the software programming utility connected directly to the CPU.

F. System Display

1. The system shall support the following display mode options:

   a. 640-character display option. The design of the CPU shall provide for a configuration with the 640 Character display mounted on the front of the CPU in place of the standard 80-character display.
   b. When configured with a 640-character display option the system shall support distributed digital audio amplifiers on the digital audio loop.

2. The display shall provide all the controls and indicators used by the system operator:

   a. The 640-character display shall include the following operator control switches: ACKNOWLEDGE, ALARM SILENCE, ALARM ACTIVATE (drill), SYSTEM RESET, and LAMP TEST.

3. The display shall annunciate status information and custom alphanumeric labels for all intelligent detectors, addressable modules, internal panel circuits, and software zones.
4. The 640-character display shall provide 11 Light-Emitting-Diodes (LEDs), that indicate the status of the following system parameters: AC POWER, FIRE ALARM, PREALARM WARNING, SECURITY ALARM, SUPERVISORY EVENT, SYSTEM TROUBLE, ALARM SILENCED, DISABLED POINTS, OTHER EVENTS, CPU FAILURE and Controls Active.
5. The display shall have QWERTY type keypad.

   a. The 640-character display shall use 10 "soft" keys for screen navigation or to accomplish dedicated programming functions. Full programming access shall require use of a laptop and the proper programming utility.

G. Signaling Line Circuits (SLC)

1. Each FACP or FACP network node shall support up to two SLCs. Each SLC interface shall provide power to and communicate with up to 159 intelligent detectors (ionization, photoelectric or thermal) and 159 intelligent modules (monitor or control) for a loop capacity of 318 devices. The addition of the optional second loop shall double the device capacity, supporting a total of 636 devices. Each SLC shall be capable of NFPA 72 Style 4, Style 6, or Style 7 (Class A or B) wiring.
2. CPU shall receive analog information from all intelligent detectors to be processed to determine whether normal, alarm, prealarm, or trouble conditions exist for each detector. The software shall automatically maintain the detector's desired sensitivity level by adjusting for the effects of environmental factors, including the accumulation of dust in each detector. The analog information shall also be used for automatic detector testing and for the automatic determination of detector maintenance requirements.

H. Serial Interfaces

1. The system shall include two serial EIA-232 interfaces. Each interface shall be a means of connecting UL Listed Information Technology Equipment (ITE) peripherals.

    a. One EIA-232 interface shall be used to connect an UL-Listed 40 column printer. Printers that are not UL-Listed are not considered acceptable substitutes.
    b. The system shall include an EIA-485 port for the serial connection of optional annunciators and remote LCD displays.
    c. The EIA-485 interface may be used for network connection to a proprietary-receiving unit.

I. Digital Voice Command Center – one for each building

1. The Digital Voice Command Center located with the FACP, shall contain all equipment required for all audio control, emergency telephone system control, signaling and supervisory functions. This shall include speaker zone indication and control, telephone circuit indication and control, digital voice units, microphone and main telephone handset. The DVC shall support up to 8 channels of voice when configured with Digital Audio Amplifiers and 4 channels of voice when employing the optional analog output card. Each DVC shall support up to 32 digital audio amplifiers.
2. Function: The Voice Command Center equipment shall perform the following functions:

    a. Operate as a supervised multi-channel emergency voice communication system.
    b. Operate as a two-way emergency telephone system control center.
    c. Audibly and visually annunciate the active or trouble condition of every speaker circuit and emergency telephone circuit.
    d. Audibly and visually annunciate any trouble condition for digital tone and voice units required for normal operation of the system.
    e. Provide all-call Emergency Paging activities through activation of a single control switch.
    f. As required, provide vectored paging control to specific audio zones via dedicated control switches.
    g. Provide a factory recorded "library" of voice messages and tones in standard WAV. File format, which may be edited and saved on a PC running a current Windows® operating system.
    h. Provide a software utility capable of off-line programming for the VCC operation and the audio message files. This utility shall support the creation of new programs as well as editing and saving existing program files. Uploading or

downloading the VCC shall not inhibit the emergency operation of other nodes on the fire alarm network.

i. Support an optional mode of operation with four analog audio outputs capable of being used with UL 864 fire-listed analog audio amplifiers and SCL controlled switching.
j. The Digital Voice Command shall be modular in construction, and shall be capable of being field programmable without requiring the return of any components to the manufacturer and without requiring use of any external computers or other programming equipment.
k. The Digital Voice Command and associated equipment shall be protected against unusually high voltage surges or line transients.

3. The emergency voice alarm communication system shall incorporate a Two-way emergency telephone communication system.

a. Two-way emergency telephone communication circuits shall be supervised for open and short circuit conditions.
b. Two-way emergency telephone (Fire Fighter Telephone) communication shall be supported between the Digital Voice Command Center and up to seven (7) remote Fire Fighter's Telephone locations simultaneously on a telephone riser.
c. Means shall be provided to connect FFT voice communications to the speaker circuits in order to allow voice paging over the speaker circuit from a telephone handset.

J. Audio Amplifiers

1. The Audio Amplifiers will provide Audio Power (@25 Volt RMS or 70 RMS) for distribution to speaker circuits.
2. Multiple audio amplifiers may be mounted in a single enclosure, either to supply incremental audio power, or to function as an automatically switched backup amplifier(s).
3. The audio amplifier shall include an integral power supply, and shall provide built-in LED indicators for the following conditions:

a. Earth Fault on DAP A (Digital Audio Port A)
b. Earth Fault on DAP B (Digital Audio Port B)
c. Audio Amplifier Failure Detected Trouble
d. Active Alarm Bus input
e. Audio Detected on Aux Input A
f. Audio Detected on Aux Input B
g. Audio Detected on Firefighter's Telephone Riser
h. Receiving Audio from digital audio riser
i. Short circuit on speaker circuit 1
j. Short circuit on speaker circuit 2
k. Short circuit on speaker circuit 3
l. Short circuit on speaker circuit 4
m. Data Transmitted on DAP A
n. Data Received on DAP A
o. Data Transmitted on DAP B
p. Data Received on DAP B
q. Board failure
r. Active fiber optic media connection on port A (fiber optic media applications)
s. Active fiber optic media connection on port B (fiber optic media applications)
t. Power supply Earth Fault
u. Power supply 5V present

v. Power supply conditions - Brownout, High Battery, Low Battery, Charger Trouble

4. The audio amplifier shall provide the following built-in controls:

   a. Amplifier Address Selection Switches
   b. Signal Silence of communication loss annunciation Reset
   c. Level adjustment for background music
   d. Enable/Disable for Earth Fault detection on DAP A
   e. Enable/Disable for Earth Fault detection on DAP A
   f. Switch for 2-wire/4-wire FFT riser

5. Adjustment of the correct audio level for the amplifier shall not require any special tools or test equipment.
6. Includes audio input and amplified output supervision, back up input, and automatic switch over function, (if primary amplifier should fail).
7. System shall be capable of backing up digital amplifiers.
8. One-tone backup shall be provided by either a plug-in-amplifier card or a designated backup amplifier of identical model as the primary amplifier.
9. One designated backup amplifier shall be capable of backing up multiple primary amplifiers mounted in the same or adjacent cabinets.
10. Multi-channel operation from a single amplifier shall be supported by the addition of an optional plug-in amplifier card.

K. Audio Message Generator (Prerecorded Voice)/Speaker Control:

1. Each initiating zone or intelligent device shall interface with an emergency voice communication system capable of transmitting a prerecorded voice message to all speakers in the building.
2. Actuation of any alarm initiating device shall cause a prerecorded message to sound over the speakers. The message shall be repeated four (4) times. Pre- and post-message tones shall be supported.
3. A built-in microphone shall be provided to allow paging through speaker circuits.
4. System paging from emergency telephone circuits shall be supported.
5. The audio message generator shall have the following indicators and controls to allow for proper operator understanding and control:
6. LED Indicators:

   a. Lamp Test
   b. Trouble
   c. Off-Line Trouble
   d. Microphone Trouble
   e. Phone Trouble
   f. Busy/Wait
   g. Page Inhibited
   h. Pre/Post Announcement Tone

L. Controls with associated LED Indicators:

1. Speaker Switches/Indicators

   a. The speaker circuit control switches/indicators shall include visual indication of active and trouble status for each speaker circuit in the system.
   b. The speaker circuit control panel shall include switches to manually activate or deactivate each speaker circuit in the system.

2. Emergency Two-Way Telephone Control Switches/Indicators

    a. The emergency telephone circuit control panel shall include visual indication of active and trouble status for each telephone circuit in the system.
    b. The telephone circuit control panel shall include switches to manually activate or deactivate each telephone circuit in the system.

M. Enclosures:

1. The control panel shall be housed in a UL-listed cabinet suitable for surface or semi-flush mounting. The cabinet and front shall be corrosion protected, given a rust-resistant prime coat, and manufacturer's standard finish.
2. The back box and door shall be constructed of 0.060 steel with provisions for electrical conduit connections into the sides and top.
3. The door shall provide a key lock and shall include a glass or other transparent opening for viewing of all indicators. For convenience, the door may be site configured for either right or left hand hinging.

N. Power Supply:

1. A high tech off-line switching power supply shall be available for the fire alarm control panel or network node and provide 6.0 amps of available power for the control panel and peripheral devices.
2. Provisions will be made to allow the audio-visual power to be increased as required by adding modular expansion audio-visual power supplies.
3. Positive-Temperature-Coefficient (PTC) thermistors, circuit breakers, or other over-current protection shall be provided on all power outputs. The power supply shall provide an integral battery charger for use with batteries up to 55 AH or may be used with an external battery and charger system. Battery arrangement may be configured in the field.
4. The power supply shall continuously monitor all field wires for earth ground conditions, and shall have the following LED indicators:

    a. Ground Fault LED
    b. AC Power Fail LED
    c. NAC on LED (4)

5. The main power supply shall operate on 120 VAC, 60 Hz, and shall provide all necessary power for the FACP.
6. The main power supply shall provide a battery charger using dual-rate charging techniques for fast battery recharge and be capable of charging batteries up to 200 AH.
7. All circuits shall be power-limited, per UL864 requirements.

O. Auxiliary Field Power Supply - Addressable

1. The auxiliary addressable power supply is a remote 24 VDC power supply used to power Notification Devices and field devices that require regulated 24VDC power. The power supply shall also include and charge backup batteries.
2. The addressable power supply for the fire alarm system shall provide up a minimum of 6.0 amps of 24 volt DC regulated power for Notification Appliance Circuit (NAC) power or 5 amps of 24 volt DC general power. The power supply shall have an additional .5 amp of 24 VDC auxiliary power for use within the same cabinet as the power supply. It shall include an integral charger designed to charge 7.0 - 25.0 amp hour batteries.

3. The addressable power supply shall provide four individually addressable Notification Appliance Circuits that may be configured as two Class "A" and two Class "B" or four Class "B" only circuits. All circuits shall be power-limited per UL 864 requirements.
4. The addressable power supply shall provide built-in synchronization for certain Notification Appliances on each circuit without the need for additional synchronization modules. The power supply's output circuits shall be individually selected for synchronization. A single addressable power supply shall be capable of supporting both synchronized and non-synchronized Notification Devices at the same time.
5. The addressable power supply shall operate on 120 or 240 VAC, 50/60 Hz.
6. The interface to the power supply from the Fire Alarm Control Panel (FACP) shall be via the Signaling Line Circuit (SLC) or other multiplexed means Power supplies that do not use an intelligent interface are not suitable substitutes. The required wiring from the FACP to the addressable power supply shall be a single unshielded twisted pair wire. Data on the SLC shall be transmitted between 24 VDC, 5 VDC and 0 VDC at approximately 3.33k baud.
7. The addressable power supply shall supervise for battery charging failure, AC power loss, power brownout, battery failure, NAC loss, and optional ground fault detection. In the event of a trouble condition, the addressable power supply shall report the incident and the applicable address to the FACP via the SLC.
8. The addressable power supply shall have an AC Power Loss Delay option. If this option is utilized and the addressable power supply experiences an AC power loss, reporting of the incident to the FACP will be delayed. A delay time of eight or sixteen hours shall be Dip-switch selected.
9. The addressable power supply shall have an option for Canadian Trouble Reporting and this option shall be Dip-switch selectable.
10. The addressable power supply mounts in either the FACP backbox or its own dedicated surface mounted backbox with cover.
11. Each of the power supply's four output circuits shall be DIP-switch selected for Notification Appliance Circuit or General Purpose 24 VDC power. Any output circuit shall be able to provide up to 2.5 amps of 24 VDC power.
12. The addressable power supply's output circuits shall be individually supervised when they are selected to be either a Notification Appliance Circuit when wired Class "A" or by the use of and end-of-line resistor. When the power supply's output circuit is selected as General 24VDC power, the circuit shall be individually supervised when an end-of-line relay is used.
13. When selected for Notification Appliance Circuits, the output circuits shall be individually DIP-switch selectable for Steady, March Time, Dual Stage or Temporal.
14. When selected as a Notification Appliance Circuit, the output circuits of the addressable power supply shall have the option to be coded by the use of a universal zone coder.
15. The addressable power supply shall interface and synchronize with other power supplies of the same type. The required wiring to interface multiple addressable power supplies shall be a single unshielded, twisted pair wire.
16. An individual or multiple interfaced addressable power supplies shall have the option to use an external charger for battery charging. Interfaced power supplies shall have the option to share backup battery power.

P. Field Charging Power Supply (FCPS)

Q. The FCPS is a device designed for use as either a remote 24 volt power supply or used to power Notification Appliances.

1. The FCPS shall offer up to 6.0 amps (4.0 amps continuous) of regulated 24 volt power. It shall include an integral charger designed to charge 7.0 amp hour batteries and to support 60 hour standby.

2. The Field Charging Power Supply shall have two input triggers. The input trigger shall be a Notification Appliance Circuit (from the fire alarm control panel) or a relay. Four outputs (two Style Y or Z and two style Y) shall be available for connection to the Notification devices.
3. The FCPS shall include an attractive surface mount backbox.
4. The Field Charging Power Supply shall include the ability to delay the AC fail delay per NFPA requirements.
5. The FCPS include power limited circuitry, per 1995 UL standards.

R. Specific System Operations

1. Smoke Detector Sensitivity Adjust: A means shall be provided for adjusting the sensitivity of any or all addressable intelligent detectors in the system from the system keypad. Sensitivity range shall be within the allowed UL window and have a minimum of 9 levels.
2. Alarm Verification: Each of the intelligent addressable smoke detectors in the system may be independently selected and enabled to be an alarm verified detector. The alarm verification delay shall be programmable from 5 to 30 seconds and each detector shall be able to be selected for verification. The FACP shall keep a count of the number of times that each detector has entered the verification cycle. These counters may be displayed and reset by the proper operator commands.
3. Point Disable: Any addressable device or conventional circuit in the system may be enabled or disabled through the system keypad.
4. Point Read: The system shall be able to display or print the following point status diagnostic functions:

    a. Device status
    b. Device type
    c. Custom device label
    d. View analog detector values
    e. Device zone assignments
    f. All program parameters

5. System Status Reports: Upon command from an operator of the system, a status report will be generated and printed, listing all system status.
6. System History Recording and Reporting: The fire alarm control panel shall contain a history buffer that will be capable of storing up to 800 events. Up to 200 events shall be dedicated to alarm and the remaining events are general purpose. Systems that do not have dedicated alarm storage, where events are overridden by non-alarm type events, are not suitable substitutes. Each of these activations will be stored and time and date stamped with the actual time of the activation. The contents of the history buffer may be manually reviewed, one event at a time, or printed in its entirety. The history buffer shall use non-volatile memory. Systems that use volatile memory for history storage are not acceptable substitutes.
7. Automatic Detector Maintenance Alert: The fire alarm control panel shall automatically interrogate each intelligent detector and shall analyze the detector responses over a period of time. If any intelligent detector in the system responds with a reading that is above or below normal limits, then the system will enter the trouble mode, and the particular detector will be annunciated on the system display, and printed on the optional printer. This feature shall in no way inhibit the receipt of alarm conditions in the system, nor shall it require any special hardware, special tools or computer expertise to perform.
8. Pre-Alarm Function: The system shall provide two levels of pre-alarm warning to give advance notice of a possible fire situation. Both pre-alarm levels shall be fully field adjustable. The first level shall give an audible indication at the panel. The second level

shall give an audible indication and may also activate control relays. The system shall also have the ability to activate local detector sounder bases at the pre-alarm level, to assist in avoiding nuisance alarms.

9. Software Zones: The FACP shall provide 100 software zones, 10 additional special function zones, 10 releasing zones, and 20 logic zones.
10. The fire alarm control panel shall include a walk test feature. It shall include the ability to test initiating device circuits and notification appliance circuits from the field without returning to the panel to reset the system. Operation shall be as follows:

    a. Alarming an initiating device shall activate programmed outputs, which are selected to participate in walk test, for 3 seconds.
    b. Introducing a trouble into the initiating device shall activate the programmed outputs for 8 seconds.
    c. All devices tested in walk test shall be recorded in the history buffer.

11. Waterflow Operation

    a. An alarm from a waterflow detection device shall activate the appropriate alarm message on the main panel display, turn on all programmed notification appliance circuits and shall not be affected by the signal silence switch.

12. Supervisory Operation

    a. An alarm from a supervisory device shall cause the appropriate indication on the system display, light a common supervisory LED, but will not cause the system to enter the trouble mode.

13. Signal Silence Operation

    a. he FACP shall have the ability to program each output circuit (notification, relay, speaker etc) to deactivate upon depression of the signal silence switch.

14. Non-Alarm Input Operation

    a. Any addressable initiating device in the system may be used as a non-alarm input to monitor normally open contact type devices. Non-alarm functions are a lower priority than fire alarm initiating devices.

15. Combo Zone

    a. A special type code shall be available to allow waterflow and supervisory devices to share a common addressable module. Waterflow devices shall be wired in parallel, supervisory devices in series.

2.4 SYSTEM COMPONENTS:

A. Speakers:

1. All speakers shall operate on 25 VRMS or with field selectable output taps from 0.5 to 2.0 Watts.
2. Speakers in corridors and public spaces shall produce a nominal sound output of 84 dBA at 10 feet (3m).

3. Frequency response shall be a minimum of 400 HZ to 4000 HZ.
4. The back of each speaker shall be sealed to protect the speaker cone from damage and dust.

B. Strobe lights shall meet the requirements of the ADA, UL Standard 1971, be fully synchronized, and shall meet the following criteria:

1. The maximum pulse duration shall be 2/10 of one second
2. Strobe intensity shall meet the requirements of UL 1971.
3. The flash rate shall meet the requirements of UL 1971.

C. Audible/Visual Combination Devices:

1. Shall meet the applicable requirements of Section A listed above for audibility.
2. Shall meet the requirements of Section B listed above for visibility.

D. Waterflow Indicator:

1. Waterflow Switches shall be an integral, mechanical, non-coded, non-accumulative retard type.
2. Waterflow Switches shall have an alarm transmission delay time which is conveniently adjustable from 0 to 60 seconds. Initial settings shall be 30-45 seconds.
3. All waterflow switches shall come from a single manufacturer and series.
4. Waterflow switches shall be provided and connected under this section but installed by the mechanical contractor.
5. Where possible, locate waterflow switches a minimum of one (1) foot from a fitting which changes the direction of the flow and a minimum of three (3) feet from a valve.

E. Sprinkler and Standpipe Valve Supervisory Switches:

1. Each sprinkler system water supply control valve riser, zone control valve, and standpipe system riser control valve shall be equipped with a supervisory switch. Standpipe hose valves, and test and drain valves shall not be equipped with supervisory switches.
2. 2.PIV (post indicator valve) or main gate valves shall be equipped with a supervisory switch.
3. 3. The switch shall be mounted so as not to interfere with the normal operation of the valve and adjusted to operate within two revolutions toward the closed position of the valve control, or when the stem has moved no more than one-fifth of the distance from its normal position.
4. The supervisory switch shall be contained in a weatherproof aluminum housing, which shall provide a 3/4 inch (19 mm) conduit entrance and incorporate the necessary facilities for attachment to the valves.
5. The switch housing shall be finished in red baked enamel.
6. The entire installed assembly shall be tamper proof and arranged to cause a switch operation if the housing cover is removed, or if the unit is removed from its mounting.
7. Valve supervisory switches shall be provided and connected under this section and installed by mechanical contractor.

    a. This unit shall provide for each zone: alarm indications, using a red alarm and yellow trouble long-life LEDs and control switches for the control of fire alarm control panel functions. The annunciator will also have an ON-LINE LED, local piezo electric signal, local acknowledge/lamp test switch, and custom slide-in zone/function identification labels.

b. Switches shall be available for remote annunciation and control of output points in the system, system acknowledge, telephone zone select, speaker select, global signal silence, and global system reset within the confines of all applicable standards.

F. Alphanumeric LCD Type Annunciator:

1. The alphanumeric display annunciator shall be a supervised, remotely located back-lit LCD display containing a minimum of eighty (80) characters for alarm annunciation in clear English text.
2. The LCD annunciator shall display all alarm and trouble conditions in the system.
3. An audible indication of alarm shall be integral to the alphanumeric display.
4. The display shall be UL listed for fire alarm application.
5. It shall be possible to connect up to 32 LCD displays and be capable of wiring distances up to 6,000 feet from the control panel.
6. The annunciator shall connect to a separate, dedicated "terminal mode" EIA-485 interface. This is a two-wire loop connection and shall be capable of distances to 6,000 feet. Each terminal mode LCD display shall mimic the main control panel.
7. The system shall allow a minimum of 32 terminal mode LCD annunciators. Up to 10 LCD annunciators shall be capable of the following system functions: Acknowledge, Signal Silence and Reset, which shall be protected from unauthorized use by a key switch or password.
8. The LED annunciator shall offer an interface to a graphic style annunciator and provide each of the features listed above.

G. Universal Digital Alarm Communicator Transmitter (UDACT). The UDACT is an interface for communicating digital information between a fire alarm control panel and an UL-Listed central station.

1. The UDACT shall be compact in size, mounting in a standard module position of the fire alarm control cabinet. Optionally, the UDACT shall have the ability for remote mounting, up to 6,000 feet from the fire alarm control panel. The wire connections between the UDACT and the control panel shall be supervised with one pair for power and one pair for multiplexed communication of overall system status. Systems that utilize relay contact closures are not acceptable.
2. The UDACT shall include connections for dual telephone lines (with voltage detect), per UL/NFPA/FCC requirements. It shall include the ability for split reporting of panel events up to three different telephone numbers.
3. The UDACT shall be completely field programmable from a built-in keypad and 4 character red, seven segment display.
4. The UDACT shall be capable of transmitting events in at least 15 different formats. This ensures compatibility with existing and future transmission formats.
5. Communication shall include vital system status such as:

a. Independent Zone (Alarm, trouble, non-alarm, supervisory)
b. Independent Addressable Device Status
c. AC (Mains) Power Loss
d. Low Battery and Earth Fault
e. System Off Normal
f. 12 and 24 Hour Test Signal
g. Abnormal Test Signal (per UL requirements)
h. EIA-485 Communications Failure
i. Phone Line Failure

6. The UDACT shall support independent zone/point reporting when used in the Contact ID format. In this format the UDACT shall support transmission of up to 2,040 points. This enables the central station to have exact details concerning the origin of the fire or response emergency.
7. AN IP Communicator option shall be available to interface to the UDACT and be capable of transmitting signals over the internet/intranet to a compatible receiver.

H. Field Wiring Terminal Blocks

I. For ease of service all panel I/O wiring terminal blocks shall be removable, plug-in types and have sufficient capacity for #18 to #12 AWG wire. Terminal blocks that are permanently fixed are not acceptable.

2.5 SYSTEM COMPONENTS - ADDRESSABLE DEVICES

A. Addressable Devices - General

1. Addressable devices shall use simple to install and maintain decade, decimal address switches. Devices shall be capable of being set to an address in a range of 001 to 159.
2. Addressable devices, which use a binary-coded address setting method, such as a DIP-switch, are not an allowable substitute.
3. Detectors shall be intelligent (analog) and addressable, and shall connect with two wires to the fire alarm control panel Signaling Line Circuits.
4. Addressable smoke and thermal detectors shall provide dual alarm and power/polling LEDs. Both LEDs shall flash green under normal conditions, indicating that the detector is operational and in regular communication with the control panel, and both LEDs shall be placed into steady red illumination by the control panel, indicating that an alarm condition has been detected. If required, the LED flash shall have the ability to be removed from the system program. An output connection shall also be provided in the base to connect an external remote alarm LED.
5. The fire alarm control panel shall permit detector sensitivity adjustment through field programming of the system. The panel on a time-of-day basis shall automatically adjust sensitivity.
6. Using software in the FACP, detectors shall automatically compensate for dust accumulation and other slow environmental changes that may affect their performance. The detectors shall be listed by UL as meeting the calibrated sensitivity test requirements of NFPA Standard 72, Chapter 7.
7. The detectors shall be ceiling-mount and shall include a separate twist-lock base with tamper proof feature. Bases shall include a sounder base with a built-in (local) sounder rated at 85 DBA minimum, a relay base and an isolator base designed for Style 7 applications.
8. The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself (by activating a magnetic switch) or initiated remotely on command from the control panel.
9. Detectors shall also store an internal identifying type code that the control panel shall use to identify the type of device (ION, PHOTO, THERMAL).
10. Detectors will operate in an analog fashion, where the detector simply measures its designed environment variable and transmits an analog value to the FACP based on real-time measured values. The FACP software, not the detector, shall make the alarm/normal decision, thereby allowing the sensitivity of each detector to be set in the FACP program and allowing the system operator to view the current analog value of each detector.

11. Addressable devices shall store an internal identifying code that the control panel shall use to identify the type of device.
12. A magnetic test switch shall be provided to test detectors and modules. Detectors shall report an indication of an analog value reaching 100% of the alarm threshold.
13. Addressable modules shall mount in a 4-inch square (101.6 mm square), 2-1/8 inch (54 mm) deep electrical box. An optional surface mount Lexan enclosure shall be available.

B. Addressable Manual Fire Alarm Box (manual station)

1. Addressable manual fire alarm boxes shall, on command from the control panel, send data to the panel representing the state of the manual switch and the addressable communication module status. They shall use a key operated test-reset lock, and shall be designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key.
2. All operated stations shall have a positive, visual indication of operation and utilize a key type reset.
3. Manual fire alarm boxes shall be constructed of Lexan with clearly visible operating instructions provided on the cover. The word FIRE shall appear on the front of the stations in raised letters, 1.75 inches (44 mm) or larger.

C. Intelligent Photoelectric Smoke Detector

1. The detectors shall use the photoelectric (light-scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density.

D. Intelligent Thermal Detectors

1. Thermal detectors shall be intelligent addressable devices rated at 135 degrees Fahrenheit (58 degrees Celsius) and have a rate-of-rise element rated at 15 degrees F (9.4 degrees C) per minute. It shall connect via two wires to the fire alarm control panel signaling line circuit.

E. Intelligent Duct Smoke Detector

1. The smoke detector housing shall accommodate either an intelligent ionization detector or an intelligent photoelectric detector, of that provides continuous analog monitoring and alarm verification from the panel.
2. When sufficient smoke is sensed, an alarm signal is initiated at the FACP, and appropriate action taken to change over air handling systems to help prevent the rapid distribution of toxic smoke and fire gases throughout the areas served by the duct system.

F. Addressable Dry Contact Monitor Module

1. Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional alarm initiating devices (any N.O. dry contact device) to one of the fire alarm control panel SLCs.
2. The IDC zone shall be suitable for Style D or Style B operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.
3. For difficult to reach areas, the monitor module shall be available in a miniature package and shall be no larger than 2-3/4 inch (70 mm) x 1-1/4 inch (31.7 mm) x 1/2 inch (12.7 mm). This version need not include Style D or an LED.

G. Addressable Control Module

1. Addressable control modules shall be provided to supervise and control the operation of one conventional NACs of compatible, 24 VDC powered, polarized audio/visual notification appliances.
2. The control module NAC may be wired for Style Z or Style Y (Class A/B) with a current rating of 2 Amps for Style Z and 3 Amps for Style Y. For speaker applications the module is rated for 50 watts at 25 or 70.7 Vrms.
3. Audio/visual power shall be provided by a separate supervised power circuit from the main fire alarm control panel or from a supervised UL listed remote power supply.

H. Addressable Relay Module

1. Addressable Relay Modules shall be available for HVAC control and other building functions. The module shall provide two form C relays rated at up to 3 Amps resistive and up to 2.0 Amps inductive. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to insure that 100% of all auxiliary devices energize at the same time on the same pair of wires.
2. For multiple relay control a module shall be available that provides 6 programmable Form-C relays.

I. Addressable Releasing Control Module

1. An addressable FlashScan releasing module shall be available to supervise and control compatible releasing agent solenoids.
2. The module shall operate on a redundant protocol for added protection.
3. The module shall be configurable for Style Z or Style Y (Class A/B) and support one 24 volt or two 12 volt solenoids.

J. Isolator Module

1. Isolator modules shall be provided to automatically isolate wire-to-wire short circuits on an SLC Class A or Class B branch. The isolator module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the SLC loop segment or branch. At least one isolator module shall be provided for each floor or protected zone of the building.
2. If a wire-to-wire short occurs, the isolator module shall automatically open-circuit (disconnect) the SLC. When the short circuit condition is corrected, the isolator module shall automatically reconnect the isolated section.
3. The isolator module shall not require address-setting, and its operations shall be totally automatic. It shall not be necessary to replace or reset an isolator module after its normal operation.
4. The isolator module shall provide a single LED that shall flash to indicate that the isolator is operational and shall illuminate steadily to indicate that a short circuit condition has been detected and isolated.

2.6 BATTERIES:

A. The battery shall have sufficient capacity to power the fire alarm system for not less than forty eight hours plus 5 minutes of alarm upon a normal AC power failure.

B. The batteries are to be completely maintenance free. No liquids are required. Fluid level checks for refilling, spills, and leakage shall not be required.

C. Provide minimum 30% spare capacity

D. If necessary to meet standby requirements, external battery and charger systems may be used.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. Installation shall be in accordance with the NEC, NFPA 72, local and state codes, as shown on the drawings, and as recommended by the major equipment manufacturer.

B. All conduit, junction boxes, conduit supports and hangers shall be concealed in finished areas and may be exposed in unfinished areas. Smoke detectors shall not be installed prior to the system programming and test period. If construction is ongoing during this period, measures shall be taken to protect smoke detectors from contamination and physical damage.

C. All fire detection and alarm system devices, control panels and remote annunciators shall be flush mounted when located in finished areas and may be surface mounted when located in unfinished areas.

D. Manual fire alarm boxes shall be suitable for surface mounting or semi-flush mounting as shown on the plans, and shall be installed not less than 42 inches (1067 mm), nor more than 48 inches (122 mm) above the finished floor.

3.2 TEST:

A. The service of a competent, factory-trained engineer or technician authorized by the manufacturer of the fire alarm equipment shall be provided to technically supervise and participate during all of the adjustments and tests for the system. All testing shall be in accordance with NFPA 72, Chapter 7.

B. Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.

C. Close each sprinkler system flow valve and verify proper supervisory alarm at the FACP.

D. Verify activation of all waterflow switches.

E. Open initiating device circuits and verify that the trouble signal actuates.

F. Open and short signaling line circuits and verify that the trouble signal actuates.

G. Open and short notification appliance circuits and verify that trouble signal actuates.

H. Ground all circuits and verify response of trouble signals.

I. Check presence and audibility of tone at all alarm notification devices.

J. Check installation, supervision, and operation of all intelligent smoke detectors using the walk test.

K. Each of the alarm conditions that the system is required to detect should be introduced on the system. Verify the proper receipt and the proper processing of the signal at the FACP and the correct activation of the control points.

L. When the system is equipped with optional features, the manufacturer's manual shall be consulted to determine the proper testing procedures. This is intended to address such items as verifying controls performed by individually addressed or grouped devices, sensitivity monitoring, verification functionality and similar.

3.3 FINAL INSPECTION:

A. At the final inspection, a factory-trained representative of the manufacturer of the major equipment shall demonstrate that the system functions properly in every respect.

3.4 INSTRUCTION:

A. Instruction shall be provided as required for operating the system. Hands-on demonstrations of the operation of all system components and the entire system including program changes and functions shall be provided.

B. The contractor and/or the systems manufacturer's representatives shall provide a typewritten "Sequence of Operation."

3.5 ADDITIONAL MATERIALS

A. Provide (8) speaker/strobes, (2) smoke detectors, and (1) pull station ,each with 50 feet of conduit and fire alarm wire and install at location directed by owner.

B. Any not installed shall be turned over to the owner at project completion.

END OF SECTION 283111

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Work of this Section includes but is not limited to the following:

1. Clearing and grubbing.
2. Topsoil stripping. See landscape plans and specifications for stockpiling onsite topsoil.
3. Disconnecting, demolition, and capping existing utilities.
4. Removing existing storm drains, sanitary sewers, water systems and other utilities.
5. Removing surface features, including but not limited to: asphalt concrete pavement, concrete curbs, concrete walks, retaining walls, fences, etc.
6. Potholing existing utilities.
7. Protecting existing wetlands.
8. Protecting existing trees.
9. Protecting existing utilities.

B. Related Sections include the following:

1. Section 015000, “Temporary Facilities and Controls” for temporary utilities, temporary construction and support facilities, temporary security and protection facilities, and environmental protection measures during site operations.
2. Section 312000, “Earth Moving” for soil materials, excavating, trenching, backfilling, and site grading.
3. Section 015713, “Temporary Erosion and Sediment Control” for temporary erosion control measures and requirements of the NPDES under the Washington State Department of Ecology’s General Permit for Stormwater Discharges from Construction Activities.
4. Section 015639, “Temporary Tree Protection”.

1.3 REFERENCE STANDARDS

A. WSDOT Standard Specifications for Road, Bridge and Municipal Construction, latestedition.

B. WSDOT Standard Plans for Municipal Construction, latest edition.

C. Conform to OSHA (Occupational Safety and Health Act) requirements.

D. Conform to WISHA (Washington State Industrial Safety and Health Act) for trench safety.

E. Washington State Department of Ecology’s General Permit for Stormwater.

F. Washington State Administrative Code 173-160 for abandonment of existing wells.

1.4 DEFINITIONS

A. Demolish: Where the term “demolish” is used within the Contract Documents, it shall mean the workinclusive of all labor, materials, and equipment for complete removal of the specified item, hauling the item off the project site,and disposal at a permitted location.

B. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

C. Utilities: Above ground or underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.5 MATERIALS OWNERSHIP

A. Except for materials, including topsoil, indicated to be stockpiled or to remain Owner's property, cleared materials shall become Contractor's property and shall be removed from the site.

1.6 SUBMITTALS

A. Submit under provisions of Section 013300, “Submittal Procedures” and as further provided.

B. Submittals that have been submitted and approved shall be available onsite for reference by the Owner and Engineer.

C. Submit traffic control plan to City of Kenmore and Architect.

1. Plan shall address necessary traffic control such as signage, flaggers, haul routes, access and other measures to ensure safety of the public and ongoing use of the site by the Owner.

D. Photographs or videotape, sufficiently detailed, of existing conditions of trees and plantings, adjoining construction, and site improvements that might be misconstrued as damage caused by site clearing.

E. Record drawings according to Section 017700, “Closeout Procedures” and Section 017839, “Project Record Documents.”

1. Identify and accurately locate capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.7 QUALITY ASSURANCE

A. Maintain at least one copy of the WSDOT Standard Specifications for Road, Bridge and Municipal Construction, latest edition, and the project plans and specifications on-site.

B. Field inspection and testing shall be performed under provisions of Section 014000, “Quality Requirements.”

C. Tests and analysis of aggregate material shall be performed in accordance with ANSI/ASTM D1557, ASTM D2922, ASTM D3017, ASTM D4318, and ASTM C136, as applicable.

D. If tests indicate materials do not meet specified requirements, change material and retest or obtain written approval of the Engineer. Costs associated with the retesting of materials shall be the responsibility of the Contractor.

1.8 INTENT

A. It is the intent of this Specification that the Contractor provide the Work defined herein, complete in every respect, and in accordance with the good practices of the trades involved in the site clearing, demolition, excavation, transport, placement, grading, backfilling and compaction of earthen materials and the requirements of this Specification, regardless of whether or not full details of such completeness, workmanship, or practices are contained herein.

B. It is the intent of this Specification that all Work complies with all applicable federal, state, and local codes, ordinances, and regulations. Nothing in the Specifications or Drawings is to be construed to allow Work not conforming to such codes. Contractor shall be responsible for following the regulations and code requirements.

1.9 PROJECT CONDITIONS

A. Contractor shall visit the site and review Construction Documents, Geotechnical Reports, Environmental Reports, and other available information to make their own determination of the site features to be demolished and removed, including all those known above- and below-grade improvements in the Base Bid.

B. Project site contains wetland areas that shall be protected from disturbance. Contractor shall take special precautions to fence off wetlands and their buffers.

C. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, driveways, walks, hydrants or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
3. Contractor shall provide all traffic control required for the Project based on local City, County, and State standards.

D. The Contractor shall utilize a utility locate service. The Contractor shall notify affected utility companies before starting work and comply with all of their requirements. The Contractor shall conform to applicable regulatory procedures when discovering hazardous or contaminated materials.

E. The locations of existing underground utilities are only approximate and have not been independently verified by the Owner or its representative. The Contractor shall determine the exact location of all existing utilities before commencing work and agrees to be fully responsible for any and all damages that happen due to the Contractor’s failure to locate exactly and preserve all underground utilities that are designated to remain.

F. Contractor shall take precautionary measures to protect existing utilities to remain. Contractor shall include any temporary shoring to ensure excavations do not impact soil stability adjacent to existing utilities and buildings.

G. Geotechnical reports of subsurface condition investigations made during the Project design are available for informational purposes only; data in these reports are not intended as representations or warranties of accuracy or continuity of conditions between field investigation points (i.e. soil borings, test pits, etc.). Owner assumes no responsibility for interpretations or conclusions drawn from this information. Where recommendations in the Geotechnical report conflicts with the Project plans and specifications, the Project plans and specifications take precedence.

1.10 REGULATORY REQUIREMENTS

A. Conform to all requirements of the City of Kenmore and National Pollution Discharge Elimination System (NPDES) under the Department of Ecology General Permit for Stormwater Discharges from Construction Activities. See Section 015713, “Temporary Erosion and Sediment Control” for additional information.

B. Conform to applicable agency code for dust control, runoff control, and disposal of the demolished material.

C. Obtain, post, and pay for required permits from authorities.

D. Notify affected utility companies before starting work and comply with their requirements.

E. Secure and pay for right-of-way use permits. Conform to associated permit requirements.

F. Do not close or obstruct streets, driveways, walks, or hydrants without appropriate permits or written authorization. Maintain emergency access as required by the local jurisdiction.

G. Conform to applicable regulatory procedures when discovering hazardous or contaminated materials, or when uncovering buried tanks.

H. Pay all related disposal fees and charges and conform to all regulations for materials disposed off-site, including asbestos-lined cement watermain, asbestos-containing building materials, storage tanks, and any environmentally hazardous substances.

I. Conform with Dept. of Ecology and Environmental Protection Agency (EPA) requirements for removal and disposal of all hazardous substances including, but not limited to, asbestos, articles containing PCB’s and storage tanks.

1.11 COORDINATION

A. Coordinate work under provisions of Section 013100, “Project Management and Coordination.”

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 PREPARATION

A. The Contractor shall survey the clearing limits per the Contract Documents and theexisting improvements to be demolished. If any ambiguity in the plans is identified, the Contractor shall issue a Request for Information to clarify the issue prior to commencement of construction.

B. Protect and maintain benchmarks and survey control points from disturbance during construction.

C. Protect existing site improvements to remain from damage during construction. Use clear markings and/or fencing to protect existing site improvements to remain.

D. Mark location of utilities to be removed or relocated.

E. Schedule and conduct pre-construction conference with Owner, Architect, Engineer, City, and Utility purveyor's representatives.

F. Provide, erect, and maintain temporary barriers and security devices as required by Section 015000, "Temporary Facilities and Controls", the Manual of Uniform Traffic Control Devices (MUTCD), and the City of Kenmore.

G. Provide neat sawcut at meet line with adjacent concrete or asphalt pavement to remain.

H. Restrict site access to the designated construction entrance(s).

I. Conform to construction sequence whereindicated on the Contract Documents.

J. Pothole and locate utilities at all locations where a proposed utility will cross or connect to an existing utility. Verify clearances and tie-in elevations prior to commencing work. Notify Engineer immediately where conflicts occur. Backfill potholes with crushed rock basecourse.

K. Provide erosion control measures indicated and other measures as necessary to prevent soil erosion and discharge of turbid stormwater.

L. Inspect and maintain erosion control facilities throughout the duration of the project.

3.2 TREE AND SHRUB PROTECTION

A. The Contractor shall preserve and protect existing trees and vegetation which are designated to remain, those outside clearing limits, and those specifically identified on the plans and in the field by flagging, from root, limb and trunk damage, including cutting, breaking, or skinning of roots, trunks or branches; smothering by stockpiled construction materials, excavated materials or vehicular traffic within branch spread (i.e. drip-line). Protection includes all trees indicated on plans to be saved and trees adjacent to the project site.See Section 015639, "Temporary Tree Protection" for additional requirements.

1. Maintain existing grade within drip-line of trees unless otherwise indicated.

B. Remove plants, undergrowth, other vegetation, and debris, except items scheduled to remain. Strip weeds and grass.

1. Use hand methods for grubbing inside the drip line of trees to remain. Strip grass materials to a maximum depth of 1inch under tree canopies. Carefully till or scarify existing grade to a depth of 1 inch.
2. Remove stumps and roots to a clear depth of 18inches below subgrades. Remove stumps and roots to their full depth within 5 feet of underground structures, utility lines, footings, and paved areas.

C. Storage of materials and construction traffic is prohibited within the drip-line of vegetation to remain.

3.3 EXISTING MONITORING WELL PROTECTION

A. The Contractor shall preserve and protect existing geotechnical monitoring wells which may or may not be designated on the plans to remain, those outside clearing limits, and those specifically identified on the plans and in the field by flagging. Protection includes all monitoring wells whether or not indicated on the plans or identified by the Architect or Owner to be saved.

B. Existing wells shall be clearly marked in the field and protected during construction.

C. Existing wells that cannot be protected due to construction activities shall be brought to the attention of the Geotechnical Engineer and shall be decommissioned. The Contractor shall notify the Geotechnical Engineer at least 72 hours in advance of decommissioning existing wells so that data logger instrumentation may be removed from wells to be decommissioned. The wells shall then be decommissioned by a Washington State licensed water well driller in accordance with Washington Administrative Code (WAC) Section 173-160. Copies of well decommissioning reports shall be submitted to the Department of Ecology by the licensed well driller, as required, and copies of the decommissioning reports shall be provided to the Owner and Geotechnical Engineer at the same time they are submitted to Ecology.

3.4 UTILITIES

A. Execution: Verify that the limits of clearing and demolition are defined in the plan and field. Mark location of utilities. Clearly and separately identify the location of utilities near the demolition area that are not to be demolished. Conduct demolition activities to avoid interrupting services to utilities that remain.

B. Existing Utilities: All existing utilities shall be demolished from beneath building areas.Utility interruptions shall not be allowed during occupied hours unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Architect not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect’s written permission.
3. Contact utility-locator service for area where work will be performed.

C. Utility systems to be demolished shall be capped at the property line or as shown on the plans. Demolished materials shall be removed and disposed of off-site by the Contractor in a permitted disposal area off the project site.

1. Trenches remaining from the demolished utility shall be backfilled as required under Section 312000, “Earth Moving.”
2. Utilities may be abandoned in place only if within future landscape areas. Utility to be abandoned shall be capped and filled with Controlled Density Fill.

D. Contractor shall provide coordination with all serving utility agencies.

E. Contractor shall not damage existing utilities to remain. Repair, replacement, and cleaning of any damaged utilities indicated to remain shall be provided by the Contractor at no additional cost to the Owner.

F. Contractor shall take precautionary measures to protect existing utilities. Contractor shall include any temporary shoring to ensure excavations do not impact soil stability adjacent to existing utilities.

G. If workers enter any trench or other excavation 4 feet or more in depth that does not meet the open pit requirements of WSDOT Section 2-09.3(3)B, it shall be shored and cribbed. All trench safety systems shall meet the requirements of the Washington Industrial Safety and Health Act, Chapter 49.17 RCW.

3.5 DEMOLITION REQUIREMENTS

A. Conduct demolition to minimize interference with adjacent improvements.

B. Conduct operations with minimum interference to public or private accesses. Maintain protected egress and ingress at all times.

C. Obtain written permission from adjacent property owners when demolition equipment will traverse, infringe upon, or limit access to their property.

D. Sprinkle work area with water to minimize dust. Provide hoses and water connections for this purpose based on the requirements of the water purveyor.

E. Provide and maintain temporary erosion and sediment control facilities throughout the performance of the work. Leave facilities in place until all disturbed areas are permanently stabilized and approved by the City of Kenmore and the Owner.

F. All existing utilities shall be demolished from beneath building areas.

G. Demolish existing asphalt pavement and concrete surfacing as indicated. Asphalt materials shall be removed from the site and shall be disposed of at an agency-approved location for acceptance of asphalt materials.

H. Remove demolished plant materials and miscellaneous demolition debris from the site and haul to an approved disposal location.

I. Burial or burning of material to be removed is not permitted onsite. Maintain site in clean condition.

J. Blasting is not allowed.

K. Pay all related disposal fees and charges for materials disposed of off-site, including asbestos-containing materials if applicable, appliances, and miscellaneous debris.

L. Decommission, remove, and dispose off-site all underground storage tanks (UST) unless otherwise indicated. Comply with Washington State Department of Ecology guidelines.

M. Decommission and remove all septic and drinking water wells whether or not shown on the plans unless otherwise indicated. Comply with Washington State Department of Ecology and local Department of Health guidelines.

3.6 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, grass, and other vegetation to permit installation of new construction. Removal includes digging out stumps, obstructions, and grubbing roots.
   1. Remove stumps and roots of 1½-inch-diameter and larger to a depth of 3 feet.
   2. Do not remove trees indicated to remain.

B. Remove debris, rock, and extracted plantings from the site and haul to an approved disposal location. Do not burn or bury materials onsite.

C. Fill depressions caused by clearing, grubbing, and utility removal with appropriate fill material for designated area, unless further excavation or earthwork is indicated.

   1. Place fill material in horizontal layers not exceeding 8-inch loose thickness, and compact each layer to a density equal to adjacent original ground, unless otherwise specified on the plans.

D. Within a distance of 5 feet beyond the building footprint, all roots and organic matter shall be removed and disposed off-site at an approved location.

3.7 TOPSOIL STRIPPING AND STOCKPILING

A. See landscape plans and specifications for topsoil discing, stripping, and stockpiling requirements/locations.Contractor shall utilize onsite, native topsoil as a part of developing new landscaped areas.

B. Strip topsoil to whatever depths are encountered in a manner to prevent intermingling with underlying non-organic subsoil.

   1. Strip surface soil of unsuitable topsoil, including trash, debris, weeds, roots, and other waste materials.
   2. Consult Geotechnical Report regarding depths of topsoil likely to be encountered.

3.8 EXISTING IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and as necessary to facilitate new construction.

B. Removed items include, but are not limited to, asphalt paving, curbs, gutters, fences, aggregate bases, and utilities.

1. Neatly sawcut length of existing pavement to remain, before removing existing pavement. Sawcut faces vertically.

3.9 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Remove obstructions, demolished materials, and waste materials, including trash and debris, and legally dispose of them off Owner's property.

B. Remove excess soil, unsuitable soil, and existing topsoil.

END OF SECTION 311000

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. In general, work of this Section includes, but is not necessarily limited to, the following:

1. General excavation, filling, and compaction.
2. Temporary and permanent slopes and shoring.
3. Excavating and backfilling for structures.
4. Excavating and backfilling for walks and pavement.
5. Excavating and backfilling trenches for utilities.
6. Dewatering for building foundation and utility excavations.
7. Rough and final grading of the site from existing conditions to the lines and grades shown on plans.
8. Wet weather earthwork.
9. Preparing subgrades for foundations, slabs-on-grade, walks, pavements, walls, and landscaped areas.
10. Importing required soil materials.
11. Crushed surfacing for concrete walks and asphalt paving.
12. Capillary break under building slabs.
13. Over-excavation of unsuitable soils.

B. Related Sections include the following:

1. Section 015000, “Temporary Facilities and Controls.”
2. Section 015713, “Temporary Erosion and Sediment Control” for slope protection and erosion control.
3. Section 311000, “Site Clearing and Demolition” for site stripping, grubbing, and removing topsoil.
4. Division 33, “Utilities” sections for requirements specific to particular utilities.

1.3 REFERENCES

A. ANSI/ASTM D1556 – Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.

B. ANSI/ASTM D1557 – Standard Test Methods for Laboratory Compaction Characteristics of Soils using Modified Effort.

C. ASTM D2922 – Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

D. ASTM D2487 – Standard Classification of Soils for Engineering Purposes.

E. AASHTO - M147 – Materials for Aggregate and Soil-Aggregate.

F. ANSI/ASTM C136 – Standard Method for Sieve Analysis of Fine and Coarse Aggregates.

G. ASTM D3017 – Standard Test Methods for Moisture Content of Soil and Rock in Place by Nuclear Method.

H. Bid Package Geotechnical Engineering Report prepared by Associated Earth Sciences, Inc.

1.4 REFERENCE STANDARDS

A. WSDOT: Standard Specifications for Road, Bridge and Municipal Construction, latest Edition.

B. WSDOT: Standard Plans for Municipal Construction, latest Edition.

C. AASHTO: American Association of State Highway and Transportation Officials standards.

1.5 DEFINITIONS

A. NPDES: National Pollution Discharge Elimination System permit through the Washington State Department of Ecology.

B. Backfill: Soil materials used to fill excavations and trenches placed at a specified degree of compaction.

1. Initial Backfill: Backfill placed beside and over an excavation, pipe or structure in a trench, including haunches to support sides of pipe or structure.
2. Final Backfill: Backfill placed over initial backfill to fill a trench or excavation.

C. Crushed Surfacing: Gravel layer placed between compacted subgrade and final surfacing.

D. Pipe Bedding: Gravel layer placed over excavated subgrade in a trench before laying pipe.

E. Borrow: Satisfactory soil imported from off-site for use as fill or backfill.

F. Excavation: Removal of material encountered above subgrade elevations or as indicated on project documents.

G. Concealed Condition: Conditions encountered that are subsurface or otherwise concealed physical conditions which differ materially from those indicated in the Contract Documents or unknown physical conditions of an unusual nature, which differ materially from those ordinarily found to exist and generally recognized as inherent construction activities of the character provided for in the Contract Documents.

H. Unauthorized excavation: Excavation below subgrade elevations or beyond indicated dimensions/elevations in the project documents without approval by the Geotechnical Engineer. Remedial work to correct unauthorized excavations as directed by the Geotechnical Engineer shall be performed by the Contractorwithout additional compensation.

I. Fill: Soil materials placed at a specified degree of compaction used to obtain an indicated grade or elevation.

J. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits and boulders of rock material 3/4 cubic yard or more in volume, that when tested by an independent geotechnical testing agency according to ASTM D1586, exceeds a standard penetration resistance of 100 blows/2 inches.

K. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, vaults, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

L. Support Zone: All soils below a line that begins at the edge of the structure and is projected downward and away from the structure at an inclination of 1H:1V.

M. Subgrade: Surface or elevation remaining after completing earthwork activities (excavation, fill, and grading) as indicated in the Contract Documents immediately below paving surfacing, building slab and capillary break, or topsoil materials.

N. Utilities: Onsite and offsite underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

O. Unsuitable Soil: Existing fill, in-situ soil, or other material that can be identified as having insufficient strength characteristics or stability to support the intended loads. Unsuitable soil also includes imported or onsite soil containing organics, construction debris, or other deleterious material that the Geotechnical Engineer determines unacceptable to meet project requirements.

P. Wet Weather Earthwork: Earthwork performed between dates of October 1 and April 30 or during wet weather regardless of the time of year.

Q. WSDOT: Washington State Department of Transportation.

R. Structural Fill: Soil placed as fill and compacted to a minimum of 95 percent of its maximum dry density as defined by ASTM D1557.

S. Imported Structural Fill: Soils not native to the site from offsite sources placed as fill and compacted to a minimum of 95 percent of its maximum dry density as defined by ASTM D1557.

T. Capillary Break: Gravel layer placed between compacted subgrade and building concrete slab to prevent capillary rise of moisture.

U. Over-Excavation: Excavation below subgrade elevations or beyond excavation elevations indicated in the project documents as identified and directed by the Geotechnical Engineer based on construction field data and observations. Over-excavation and imported replacement structural fill is included in the Base Bid and shall be paid for according to Contract provisions outlined in Section 012200 – Unit Prices.

1.6 SUBMITTALS

A. Submit under provisions of Section 013300 “Submittals Procedures” and as further provided.

B. Submittals that have been submitted and approved shall be available onsite for reference by the Owner and Engineer.

C. Before starting dewatering operations, the Contractor shall submit to the Architect and Engineer a statement of the method, installation, and details of the dewatering system proposed for use. If required by the City of Kenmore, the Contractor shall submit the statement of method and supporting dewatering plan to City of Kenmore for review and approval.

1. See Geotechnical Report for groundwater conditions to expect during construction.

D. Submit 60-pound samples sealed in airtight containers, of each proposed soil material from onsite or borrow sources. Submit samples to Geotechnical Engineer at least 72 hours in advance of intended use.

E. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following requirements:

1. Classification according to ASTM D2487 of imported structural fill and imported clean granular fill.
2. Laboratory compaction curve according to ASTM D1557 for each onsite or borrow soil material proposed for fill or backfill.
3. Laboratory grain size analysis per ANSI/ASTM C136.

F. Certification:

1. Provide a letter, signed by the supplier and reviewed and also signed by an officer of the Contractor's company, certifying that the following products to be incorporated into the work meet the requirements specified.
2. All product submittals shall be submitted to the Engineer for review and approval. Earthwork construction shall not commence until all submittals have been approved by the Engineer.
3. Products:
   a. Crushed Surfacing Base and Top Course
   b. Gravel Backfill for Drains
   c. Gravel Backfill for Utility Trenches
   d. Wall Backfill
   e. Imported Structural Fill
   f. Imported General Site Fill
   g. Pipe Bedding
   h. Capillary Break Gravel
   i. Detectable Warning Tape

1.7 PROJECT CONDITIONS

A. Interruptions of Existing Utilities: Utility interruptions will not be allowed during occupied hours unless permitted under the following conditions and then only after arranging to provide temporary utility services according to the requirements indicated:

1. Notify Architect and Owner not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect's written permission.
3. Contact utility locator service for the area where work shall be performed before excavating.
4. Preserve and protect project benchmarks.

B. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if systems are active.

C. Demolish, cap, and abandon existing utilities indicated to be abandoned in place per utility company requirements.

D. Contractor shall take precautions to protect existing utilities throughout the project site. Utility protection work shall include temporary shoring as necessary. Protect active utilities indicated on drawings. Service, utility or drainage lines now in use and not shown on drawings, if uncovered during earthwork operations, shall be protected and immediately called to the attention of the Architect. The Contractor is responsible for damage to utilities, whether shown on drawings or not, to bear all costs for repair and replacement. Remove or relocate utilities only as indicated or as directed by the Architect.

E. The locations of existing underground utilities are approximate and have not been independently verified by the Owner or its representatives. The Contractor shall determine the exact locations of all existing utilities before commencing work and agrees to be fully responsible for any and all damages that occur due to the Contractor's failure to appropriately locate utilities and preserve all underground utilities that are designated to remain.

F. Geotechnical reports of subsurface condition investigations made during the Project design are available for informational purposes only; data in these reports are not intended as representations or warranties of accuracy or continuity of conditions between field investigation points (i.e. soil borings, test pits, etc.). Owner assumes no responsibility for interpretations or conclusions drawn from this information. Where recommendations in the Geotechnical report conflicts with the Project plans and specifications, the Project plans and specifications take precedence.

G. Runoff and Erosion: Contractor shall be responsible for controlling surface and subsurface water, soil erosion, sedimentation, slope stability, and dust during work of this section. Conform to applicable requirements of the General Conditions, Division 1, WSDOT, and the latest King County Surface Water Design Manual. Provide necessary drainage, sedimentation basins, and the like. Establish final drainage patterns as early as practicable and maintain throughout the progress of work. Provide silt fence erosion control system and other perimeter protection where shown and as necessary. TESC measures shown on the engineering drawings shall be installed. Cover all soil piles with plastic sheeting regardless of weather conditions. Contractor shall be responsible for all costs associated with keeping soil piles covered.

H. Public Street: Kept free of mud, dirt, and debris AT ALL TIMES. If mud is tracked onto pavement, promptly clean pavement to satisfaction of local authorities and the Owner's Representative.

1.8 QUALITY CONTROL

A. Maintain at least one copy onsite of the WSDOT Standard Plans and Specifications for Municipal Construction, latest Edition, and project plans and specifications.

B. Field inspection and testing shall be performed under provisions of Section 014000 "Quality Control".

C. Tests and analysis of aggregate material shall be performed in accordance with ANSI/ASTM D1557, ASTM D2922, ASTMD3017, ASTM D4318, and ASTM C136, as applicable.

D. If tests indicate materials that do not meet specified requirements, provide corrective measures and retest as necessary to conform to the Contract Documents. Costs associated with modifying and the retesting of non-conforming materials shall be the responsibility of the Contractor.

E. Owner shall employ the services of a registered Geotechnical Engineer. Owner may employ the Engineer for continuous observation of earthwork. Contractor shall coordinate all work of this Section with the Geotechnical Engineer and conform work to his/her recommendations.

1.9 INTENT

A. It is the intent of this Specification that the Contractor provide the Work defined herein, complete in every respect, and in accordance with the good practices of the trades involved in the excavation, transport, placement, grading, backfilling and compaction of earthen materials and the requirements of this Specification, regardless of whether or not full details of such completeness, workmanship, or practices are contained herein.

B. It is the intent of this Specification that all Work complies with all applicable federal, state, and local codes, ordinances, and regulations. Nothing in the Specifications or Drawings is to be construed to allow Work not conforming to such codes. Contractor shall be responsible for following the regulations and code requirements.

1.10 REGULATORY REQUIREMENTS

A. Secure site development and right-of-way use permits from the City of Kenmore and utility purveyors. Conform to permit requirements.

B. Conform to agency codes for dust control, erosion and sediment control, runoff control, and disposal of demolished and cleared materials.

C. Obtain, post, and pay for required permits from authorities.

D. Notify affected utility companies before starting work and comply with their requirements.

E. If any materials that appear to be hazardous are encountered during excavation, immediately stop work and notify both Owner and Architect.

F. Environmental Protection: Comply with all requirements of public authorities having jurisdiction regarding pollution of all kinds. The Contractor shall implement the project’s TESC Plan and Stormwater Pollution Prevention and Spill Control (SWPPP) Plan.

G. Right-of-Way Use Permit: The Contractor shall obtain the right-of-way use permit, which shall include trucking routes within the County/City.

H. NPDES Permit: Contractor shall be responsible for implementing requirements of the project’s NPDES permit issued through the Washington State Department of Ecology.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from onsite excavations.

B. Onsite Structural Fill: As approved by the Geotechnical Engineer, onsite soils are suitable for structural fill during favorable dry weather conditions and if soil materials are within +/- 2% of optimum moisture and free of organic and other deleterious materials.

1. Onsite soils and existing fill is highly moisture sensitive. Use of existing fill will require moisture conditioning by drying during favorable weather conditions. Moisture sensitive soils shall not be used as structural fill during periods of wet weather as defined in Article 1.5 of this Specification.

C. Imported Structural Fill: Imported structural fill shall be clean, free-draining material per Foundation Material Class A: WSDOT Specification 9-03.17. Foundation Material Class A shall be used for over-excavation backfill under utilities in areas as determined by the Geotechnical Engineer. The Base Bid shall include Import Structural Fill under the proposed building and site retaining walls extending 2 feet laterally beyond structure or footing.

D. General Site Fill: Onsite material may be used for non-structural purposes provided it can be properly worked and compacted. Onsite materials free of sod, organic, vegetative and other deleterious materials; or imported clean granular fill consisting of sand and gravel containing, by weight, less than 15 percent passing the US No. 200 sieve. Imported material intended for General Site Fill shall meet WSDOT Standard Specification Section 9-03.14(3). The Base Bid shall include General Site Fill for all areas outside of the proposed building and site retaining walls, which consists of paved and landscaped areas.

E. Gravel Backfill for Drains: WSDOT Specification 9-03.12(4) Gravel Backfill for Drains.

F. Gravel Backfill for Utility Trenches: WSDOT Specification 9-03.14(1) Gravel Borrow or Bank Run Gravel conforming to Section 9-03.19.

G. Pipe Bedding: Conform to WSDOT Specification Section 9-03.12(3) Gravel Backfill for Pipe Zone Bedding.

H. Wall backfill: Conform to WSDOT Specification Section 9-03.12(2) Gravel Backfill for Walls.

I. Crushed Surfacing: WSDOT Specification Section 9.03.9(3) for Base Course and Top Course.

J. Capillary Break Gravel: Clean, crushed rock conforming to WSDOT Specification Section 9-03.4(2) ¾" - ½" crushed screenings. Amount of material passing the US No. 200 sieve shall not exceed 1.5 percent. Building floor slabs shall be cast atop a minimum of 4 inches depth of clean crushed rock to act as a capillary break. Areas of subgrade disturbed or loosened during construction shall be compacted to a non-yielding condition prior to placement of capillary break material. It shall also be protected from dampness by an impervious moisture barrier as specified in other sections of the Project Specifications. The moisture barrier shall be placed between the capillary break material and the concrete building slab.

K. Staging and Access Areas: Install Permeable Ballast per WSDOT Specification Section 9.03.9(2) as shown on the plans.

2.2 ACCESSORIES

A. Detectable Warning Tape: Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, minimum 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a

protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored as follows:

1. Red: Electric.
2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water systems.
5. Green: Sewer systems.

B. Locate Wire: No. 12 AWG insulated copper wire, brightly-colored plastic covering.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Contractor shall thoroughly review Geotechnical Reports and topographical survey as provided and verify current conditions of the project site.

B. Verify site conditions and limits of work as shown on the plan. Immediately notify Architect if conditions are not as shown and proceed only with written direction.

C. Verify that survey benchmark and intended elevations for the Work are as indicated.

D. Verify that Erosion and Sediment Control Measures are functional and adequate for weather conditions prior to performing any earthwork. Maintain erosion control facilities and adjust or add as necessary throughout all phases of the project.

E. Contractor shall update and modify their traffic control plan as necessary for all phases of the work to proceed with minimal disruption to the Owners use of the premises. Contractor shall coordinate the traffic control plan with the Owner on a weekly basis to plan construction activities. See Section 011100, “Summary” for additional information.

3.2 PERMITS

A. Obtain all required permits from the City of Kenmore for inspections prior to start of construction. Reference Section 007000, “General Conditions” and/or Section 011100, “Summary” for permit responsibilities.

3.3 PREPARATION

A. Identify required lines, levels, contours, and datum shown on plans. Should plans conflict with actual conditions, notify the Architect immediately and proceed only with written direction.

B. Stake and flag locations of known utilities.

C. Locate, identify, and protect utilities that remain, from damage.

D. Notify utility company to remove and relocate utilities as applicable.

E. Protect above and below grade utilities that remain.

F. Protect benchmarks, construction stakes, fences, paving, curbs, and adjacent structures from construction equipment and vehicular traffic.

G. Maintain vehicular access to the occupied areas of the project site at all times.

H. Remove all sod, root mass, topsoil, unsuitable soils, and other deleterious materials and dispose of off the site unless otherwise shown on the plans and/or directed by the Owner.

I. Protect subgrades and foundation soils against freezing temperatures or frost. Provide protective insulation materials as necessary.

J. If subgrade conditions in pavement, floor slab or sidewalk areas are soft and silty, a geotextile separation fabric, such as Mirafi 500x or approved equivalent, shall be used between the subgrade and the new fill. Contractor shall coordinate this work with the Geotechnical Engineer.

K. Provide erosion control measures including silt fence and inlet sediment protection as shown on the plans and as necessary during construction. Maintain all measures until construction is complete. Provide additional measures as necessary based on adverse weather conditions and/or changing project conditions.

L. To the maximum extent possible, existing pavements shall be used for construction access and staging to minimize the effects of erosion and to maintain construction stormwater water quality requirements by local and state agencies.

M. Site preparation in construction areas shall also include removal of all trees and vegetation, stripping of topsoil, and grubbing of stumps and roots larger than 2 inches in diameter.

N. The site shall be graded to prevent water from ponding in construction areas and/or flowing into excavations. Exposed grades shall be crowned, sloped, and smooth drum-rolled at the end of each day to facilitate drainage. Accumulated water must be removed from subgrades and work areas immediately prior to performing further work in the area.

O. Following demolition, site stripping, and excavation activities, the stripped subgrade within the building and paved areas shall be proof-rolled with heavy, rubber-tired construction equipment, such as a fully loaded, tandem-axle dump truck. Proof-rolling shall be performed prior to structural fill placement or foundation excavation. The proof-roll shall be monitored by the Geotechnical Engineer so that any soft or yielding subgrade soils can be identified. Any soft/loose, yielding soils shall be removed to a stable subgrade. The subgrade shall then be scarified, adjusted in moisture content, and recompacted to the required density. Proof-rolling shall only be performed when soil moisture contents are at or near optimum moisture content. Low areas and excavations shall then be raised to finish grade with appropriate fill material. Subgrade preparation and selection, placement, and compaction of fill shall be performed under the supervision of the Geotechnical Engineer in accordance with the Project Specifications.

3.4 PROTECTION OF EXISTING FACILITIES

A. Utilities: The Contractor shall protect from damage private and public utilities in accordance with WSDOT Standard Specifications Section 1-07.17.

B. Pavement: The Contractor shall protect from damage all pavement or paved areas intended to remain.

C. Access Streets and Roadways: Provide wheel cleaning stations to clean wheels and undercarriage of construction vehicles before leaving the construction area, as necessary to prevent soil and sediment from being carried onto school parking areas or public streets. If campus and adjacent streets are fouled, clean immediately in conformance with City of Kenmore and all governing requirements and regulations.

1. Sediments from wheel cleaning shall not be discharged to the storm drainage system.

D. Repair and/or replacement of damaged facilities shall be accomplished at the Contractor's expense.

E. Dust Control: Contractor shall sprinkle water as necessary to control dust during dry weather conditions. Do not use water to extent causing flooding, contaminated runoff, or icing.

1. Contractor shall sweep all haul routes daily.

F. Existing Trees: The Contractor shall protect from damage and construction activities all existing trees that are designated to remain on the Construction Documents.

3.5 TEMPORARY AND PERMANENT SLOPES AND SHORING

A. Maintenance of safe working conditions, including temporary excavation stability is the responsibility of the Contractor. If any excavation is greater than 4 feet deep, it shall be sloped, benched, or shored in accordance with Part N of WAC 296-155.

B. Temporary, unsupported cut slopes in unsaturated existing fill, recessional outwash soils shall be no steeper than 1.5H:1V.

C. Temporary, unsupported cut slopes in the undisturbed, unsaturated native advance outwash and till soils shall be no steeper than 1.2H:1V.

D. Permanent cut and fill slopes that are not intended to be exposed to surface water shall be constructed with a maximum slope of 2H:1V. Slopes that are intended to be exposed to surface water shall be constructed with a maximum slope of 3H:1V. All permanent cut or fill slopes shall be compacted to a minimum of 95 percent of the modified Proctor maximum dry density, as determined by ASTM D1557, and the slopes should be protected from erosion by plastic sheeting or other acceptable erosion control mechanism until vegetative cover can be established during favorable weather.

E. Excavations in proximity to structures shall not encroach into the support zone. Where sheet piling, shoring, sheeting, bracing, moveable trench boxes, or other supports are necessary, they shall be designed, furnished, placed, maintained, and removed by the Contractor.

F. All sheeting, shoring, and bracing shall be accomplished in accordance with all local and State regulatory requirements.

G. See Geotechnical Report for additional information.

3.6 DEWATERING

A. Zones of groundwater seepage and surface water should be expected and planned for during construction. Groundwater levels and extent of seepage will fluctuate depending on the time of year and weather conditions.

B. Provide a dewatering system to keep subgrades and trenches free from standing water and convey groundwater away from excavations. Dewatering systems shall include all sumps, pumps, ditches, pipes, temporary water/sediment storage tanks and treatment tanks as necessary. Maintain system until dewatering is no longer required.

C. Prevent surface water and groundwaterfrom entering excavations, ponding on prepared subgrades and existing subgrades, and flooding the project site.

D. Control of groundwater and surface water shall be such that softening of the bottom of excavations or formations of “quick” conditions or boils” during excavation shall be prevented.

E. Protect subgrades from softening, undermining, washout, and damage by rain water accumulation.

F. Reroute surface water runoff away from subgrades, trenches, and excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

G. Contractor shall be responsible for dewatering to support the construction of the building foundations, slabs, installation of utilities, and excavations.

3.7 EXPLOSIVES

A. Explosives: Contractor shall not use explosives.

3.8 GENERAL EXCAVATION

A. Excavate to subgrade elevations regardless of the character of surface encountered, including rock, soil materials, and obstructions.

1. If excavated materials are encountered that include unsuitable material for fill and backfill including rock, over-excavate unsuitable material and replace with satisfactory soil materials in conformance with this Section and as approved by the Geotechnical Engineer.

B. The Contractor shall make arrangements for the Geotechnical Engineer to observe excavation work and obtain approval of subgrade prior to placement of any fill.

C. Contractor shall be responsible for and make their own determination regarding the import of fill materials and the hauling off-site of excess materials as necessary to attain the indicated elevations. This includes work associated with general site excavation, fill, and grading required to attain subgrade elevations as defined in the Contract Documents. Import of fill material and the hauling off-site of excess material above subgrade elevations shall be included in the Base Bid. Over-excavation of unsuitable soils below subgrade elevations and the associated imported structural fill, as recommended by the Geotechnical Engineer (see Article 3.12), is included in the Base Bid and shall be paid for according to Contract provisions outlined

in Section 012200 – Unit Prices. Removal and disposal of all displaced soil from utility trench and footing excavations shall be included in the Base Bid.

D. General site fill may be stockpiled in areas onsite that do not interfere with other portions of the work. Contractor shall protect stockpiled soils from wind or erosion by covering with plastic sheeting and securing, or other effective methods. Remove soils not being reused from site. The Contractor shall confirm that there is sufficient material for the completion of the embankments before disposing of any material on or off the site. The Contractor, at their own expense, shall replace shortage of material caused by premature disposal of any material by the Contractor.

E. Direct surface water away from excavations and soil stockpile areas to prevent erosion or deterioration of materials.

F. Remove general site fill stockpiles and leave area in a clean and neat condition. Grade site to prevent standing surface water.

G. The Contractor shall condition the soil, drying or moistening, so that a dense unyielding condition results and the compaction criteria are met. The soil may require tilling to break up clods of material and to facilitate drying. The Contractor shall be responsible for this work.

3.9 EXCAVATION FOR STRUCTURES

A. Where excavating adjacent to structures, excavations shall not encroach into the support zone as defined by Article 1.5 of this specification section.

B. Extend excavations a minimum of 2 feet laterally beyond structure or footing unless otherwise shown to accommodate placement and removing of concrete formwork and installations of other services and inspections.

C. Beneath building footings and slabs, remove existing unsuitable soils as recommended by the Geotechnical Engineer. See Article 3.12 for additional details.

D. The Contractor shall notify the Architect and Geotechnical Engineer when they have encountered unsuitable soils or excavated subgrade that are inadequate to support the planned construction. The Contractor shall provide over-excavation as identified and recommended by the Geotechnical Engineer. The location and volume of the over-excavation shall be coordinated and approved by the Geotechnical Engineer prior to commencement of work. The excavated volume shall be filled and compacted to the subgrade elevations identified in the Contract Documents with Imported Structural Fill. The excavated material shall be disposed of off-site, unless otherwise noted, at a permitted location.

E. At retaining walls, remove existing unsuitable soils to native bearing soils as recommended by the Geotechnical Engineer. Replace excavated materials with Imported Structural Fill as necessary to achieve subgrade elevations.

F. Excavate or fill to indicated elevations and dimensions within a tolerance of plus or minus 0.05 feet.

1. Conform to structural details for excavation at footings and slabs on grade.

2. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
3. Excavation for Underground Tanks and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 0.10 foot. Do not disturb bottom of excavations intended for bearing surface.
4. Over-excavate at all footing locations 4-inch depth and install gravel backfill as recommended by the Geotechnical engineer.

G. Before any fill material is placed, Contractor shall proof roll the building area to identify all soft or yielding soils.

H. Owner's Geotechnical Engineer shall observe all excavations and approve subgrade prior to placement of any fill.

3.10 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches inside and outside of buildings to indicated gradient lines, depths, and elevations.

B. For natural gas systems, the Contractor is responsible for excavation, bedding, backfill and compaction. The utility purveyor will provide the pipe material and necessary fittings. Contractor shall conduct work to accommodate schedule of gas purveyor for placing pipe, testing and other necessary work. This work shall be included in the Base Bid.

C. Contractor shall perform all additional excavation required of whatever substance encountered to the lines and grades indicated on the Drawings.

D. Excavate trenches to uniform widths to provide working clearance on each side of pipe. Trench walls shall be vertical from trench bottom to 12 inches above top of pipe unless otherwise indicated.

E. Trenches shall be excavated deeper than bottom of pipe elevation to allow for placement of pipe bedding. Depth below pipe varies for each type of utility. Conform to plans and details for trench excavation and backfill requirements for type of utility being constructed.

F. All material suitable for use as backfill shall be piled in an orderly manner a sufficient distance from the bank of the trench to avoid overloading and to prevent sliding into the trench.

G. The Contractor shall perform such grading as is necessary to prevent surface water from entering the excavation.

H. Hand trim trench for bell and spigot pipe joints.

I. Remove lumped soil, rock, and boulders.

J. Before placement of any backfill, the subgrade shall be evaluated and approved by the Geotechnical Engineer.

K. Backfill and compact all excavated trench areas as specified.

3.11 EXCAVATION FOR WALKS AND PAVEMENT

A. Excavate surfaces under walks and pavements to indicated cross-sections, elevations and grades. Conform to detail indicating pavement structural sections.

B. Before any fill material is placed, Contractor shall proofroll the walk and pavement area to identify all “soft spots” under the supervision of the Geotechnical Engineer.

C. Owner’s Geotechnical Engineer shall observe excavation and approve subgrade prior to placement of any fill.

3.12 OVER-EXCAVATION OF UNSUITABLESOILS

A. The project site contains some areas of existing fill and/or contaminated soils of varying depth. The area under the proposed building and some of the proposed paved surfaces contain existing fill and/or contaminated soils not suitable for support of building foundations and paving. These areas warrant remedial preparation where it occurs. The excavation and backfill of existing fill and/or contaminated soils shall be performed under the observation of the Geotechnical Engineer. These areas require removal of the unsuitable soils and replacement with structural fill or other mitigation measures to support the planned improvements.

B. Under the proposed building and site retaining walls, the existing fill and/or contaminated soils are not suitable for support of structural loads, and shall be removed from below new foundations. The excavation and backfill of existing fill and/or contaminated soils shall be performed under the observation of the Geotechnical Engineer. The Contractor shall coordinate this work accordingly. Under proposed building foundations and site retaining walls, the existing fill and/or contaminated soils shall be completely removed until native soil suitable for structural support is exposed and/or as directed by the Geotechnical Engineer. Below floor slabs, remove existing fill soils and/or contaminated soils as directed by the Geotechnical Engineer based on observed field conditions. The exposed soils shall be proof-rolled, compacted, and observed by the Engineer. Any areas that warrant additional remediation shall be addressed in the field as recommended by the Geotechnical Engineer. The Contractor shall provide a detailed electronic survey of the over-excavation area with associated elevations below proposed subgrade elevations identified in the Contract Documents. All unsuitable soils shall be exported off-site and disposed of at an approved location. Imported structural fill shall be placed to achieve the subgrade elevations of the building as defined in the Contract Documents. Over-excavation and Imported Structural Fill associated with this work shall be included in the Base Bid and be paid for according to Contract provisions outlined in Section 012200 – Unit Prices.

C. Under proposed paved and landscaped areas, some unsuitable soils may be present that require over-excavation below subgrade. The excavation and backfill of existing fill shall be performed under the observation of the Geotechnical Engineer. The Contractor shall coordinate this work accordingly. The Geotechnical Engineer shall be onsite at all times during the construction of paved surfacing. If unsuitable soils are identified, remedial preparation of the subgrade shall be performed as directed by the Engineer based on observed field conditions. If the pavement subgrade can be compacted to 95 percent of the modified Proctor maximum dry density (ASTM D1557), no additional over-excavation is required. Soft or yielding areas as evidenced by proof-rolling (see Article 3.16) shall be over-excavated to the extent directed by the Geotechnical Engineer to provide a suitable subgrade and backfilled with structural fill. The exposed soils shall be proof- rolled, compacted, and observed by the Engineer. Any areas that warrant additional remediation shall be addressed in the field as recommended by the Geotechnical Engineer. The Contractor shall provide a detailed

electronic survey of the over-excavation area with associated elevations below proposed subgrade elevations identified in the Contract Documents. All unsuitable soils shall be exported off-site and disposed of at an approved location. Imported Structural Fill shall be placed to achieve the proposed subgrade elevations as defined in the Contract Documents. Over-excavation and Imported Structural Fill associated with this work shall be included in the Base Bid and be paid for according to Contract provisions outlined in Section 012200 – Unit Prices.

D. The Geotechnical Engineer shall be onsite at all times during the construction of proposed utilities. If unsuitable soils are identified, remedial preparation of the trench subgrade shall be performed as recommended by the Geotechnical Engineer based on observed field conditions. Remedial preparation shall include over-excavation of 18 inches below bottom of planned pipe bedding; placement of geotextile separation fabric Mirafi 500x or approved equivalent; backfilling to the bottom of planned bedding depth with material that meets WSDOT Standard Specification 9-03.17, “Foundation Material Class A”, compacted to a minimum of 90 percent of the modified Proctor maximum dry density (ASTM D1557); wrapping the separation fabric over the top of the fill with 6 inches of overlap; and placing the bedding and pipe as planned. This remedial preparation shall be applied to all utilities underlain by unsuitable soils as identified by the Geotechnical Engineer, that are subject to post-construction settlement, such as gravity sewers and rigid pipes that cannot tolerate substantial deflection at joints. Over-excavation, imported Foundation Material Class A fill, and separation fabric are included in the Base Bid and shall be paid for according to Contract provisions outlined in Section 012200 – Unit Prices.

E. The Contractor shall notify the Architect and Geotechnical Engineer when they have encountered unsuitable soils or excavated subgrade that are inadequate for support of the planned construction. The Contractor shall provide over-excavation as identified and directed by the Geotechnical Engineer. The location and volume of the over-excavation shall be coordinated and approved by the Geotechnical Engineer prior to commencement of work.

F. Where unsuitable soils or excavated subgrade is inadequate for support of the planned construction, the subgrade shall be over-excavated to expose native bearing soil or to the extent directed by the Geotechnical Engineer. The excavated space shall be filled and compacted to the subgrade elevations identified in the Contract Documents with Imported Structural Fill. The excavated material shall be disposed of off-site, unless otherwise noted, at a permitted location.

G. If the Contractor performs unauthorized over-excavation without approval from the Geotechnical Engineer, the over-excavation and associated remedial work resulting from unauthorized over-excavation shall be done by the Contractor without additional compensation.

3.13 UNAUTHORIZED EXCAVATION

A. Unauthorized excavations shall be backfilled with Imported Structural Fill. Fill and compact in accordance with requirements for structural fill.

B. Unauthorized excavation and associated backfill shall be at the Contractor’s expense.

3.14 STORAGE OF SOIL MATERIALS

A. Stockpile borrow materials and satisfactory excavated soil materials in areas onsite that will not interfere with other portions of the work. Stockpile soil materials without intermixing and cover with plastic sheeting.

1. Stockpile soil materials away from edge of excavations and steep slopes. Do not store within drip line of remaining trees.
2. Stockpiled soil materials shall be graded and shaped, and covered in accordance with the erosion control plan to minimize erosive forces.
3. Contractor shall move soil stockpiles as necessary to accommodate construction activities.

3.15 APPROVAL OF SUBGRADE

A. Notify Geotechnical Engineer when excavation has reached required subgrade.

B. If Geotechnical Engineer determines that unsatisfactory soil is present, continue excavation and replace with compacted structural fill material where indicated by the Geotechnical Engineer.

C. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as identified by Geotechnical Engineer. Additional compensation will not be considered for repair of deteriorated subgrades.

3.16 PROOFROLLING

A. Before any fill material is placed, Contractor shall proof-roll subgrade in building, pavement, and sidewalk areas with heavy pneumatic-tired equipment such as a fully loaded tandem-axle dump truck to identify soft or yielding subgrades. Do not proof roll wet or saturated subgrades. Proofrolling shall extend at least 3 feet beyond the structure and pavement areas.

B. Proofrolling shall be observed by the Geotechnical Engineer.

C. When soft or yielding subgrade is identified by the Geotechnical Engineer, the Contractor shall excavate the unsuitable soil and replace it with moisture conditioned structural fill. Structural fill shall be compacted to meet the specified compaction criteria. Onsite Structural Fill may be used as structural fill, provided it can be compacted to meet the specified compaction criteria.

3.17 FILLING AND COMPACTION

A. Contractor shall be responsible for and make their own determination regarding the import of fill materials and the hauling off-site of excess materials as necessary to attain the indicated elevations. This includes work associated with general site excavation, fill, and grading required to attain subgrade elevations as defined in the Contract Documents. Import of fill material and the hauling off-site of excess material above subgrade elevations shall be included in the Base Bid.

B. Subgrade areas shall be observed and approved by the Owner’s Geotechnical Engineer prior to placement of fill.

C. Fill site to the elevations indicated in the Contract Documents conforming to the fill requirements specified.

D. Any proposed fill soils shall be evaluated by the Geotechnical Engineer prior to their use in fills. Contractor shall provide the Geotechnical Engineer a sample of any imported and/ or onsite material 72 hours in advance of filling activities to perform a Proctor test and determine its field compaction standard. Soils in which the amount of fine-grained material (smaller than the No. 200 sieve) is greater than approximately 5 percent (measured on the minus No. 4 sieve size)

should be considered moisture sensitive. Use of moisture sensitive soil in structural fills shall be limited to favorable dry weather and dry subgrade conditions.

E. General Site Fill:

1. For general site grading outside the building and not beneath pavement and walk areas, provide moisture-controlled General Site Fill material, which meets the requirements of Paragraph 2.1 D. Contractor shall moisture-condition soils as necessary to meet compaction requirements.
2. When directed by the Geotechnical Engineer, native soils contaminated with deleterious material or which are soft and yielding shall be removed and replaced with Structural Fill. See Article 3.12 for additional details.

F. Pavement and Surfacing Fill:

1. Provide moisture-conditioned Onsite Structural Fill or Imported Structural Fill below all paved and surfaced areas as necessary. Extend the embankment at least 2 feet laterally beyond asphalt and concrete paved areas. Where sloping downward away from pavement, extend embankment a minimum of 3 feet from edge of pavement.
2. Excavate and remove any existing unsuitable soils as directed by the Geotechnical Engineer.

G. Building Fills:

1. Fill beneath building areas shall only consist of moisture-conditioned Onsite Structural Fill or Imported Structural Fill.
   a. Extend embankment at least 3-feet laterally beyond building foundations sloped as recommended in these Specifications.
2. At building foundations and retaining walls, backfill shall only consist of moisture-conditioned Onsite Structural Fill or Imported Structural Fill in accordance with these specifications.

H. Place structural fill material in continuous layers and compact to a firm and unyielding condition. Unless directed otherwise by the Geotechnical Engineer, compact all fills, in loose layers not exceeding 8-inch lifts to attain the following minimum compaction:

1. For subgrade and fills under building areas and other structural elements: 95 percent of maximum dry density as determined as ASTM D1557.
2. For subgrade and fills under walks and asphalt paved areas: 95 percent of maximum dry density as determined by ASTMD1557.
3. For all planting and general site fills not under paved areas: 90 percent of maximum dry density as determined by ASTM D1557.

I. Fills placed on existing slopes exceeding 5H:1V shall be keyed into the existing soil as directed by the Geotechnical Engineer. Final key and bench dimensions shall be established in the field by the Geotechnical Engineer to suit the particular soil conditions at the time of grading.

J. Maintain optimum moisture content of fill materials to attain required compaction density. See Article 3.18 – Moisture Control.

K. The top of compacted fill shall extend horizontally a minimum distance of 3 feet beyond footings or edges of pavements before sloping downward at an angle no steeper than 2H:1V.

L. Make grade changes gradual. Blend slopes into level areas.

3.18 MOISTURE CONTROL

A. The Contractor shall conduct their operation so as to utilize moisture conditioned Onsite Structural Fill or Imported Structural Fill.

1. Uniformly moisture condition, "drying" or "wetting" the subgrade before each subsequent fill or backfill layer, before compaction to within 2 percent above or below optimum moisture content.
2. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
3. Remove and replace, or scarify and air-dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact as specified.
4. Limit the areas of exposed soil during periods of wet weather. The Contractor is responsible for over-excavation of material and import of structural fill beneath subgrades that become unsuitable because it is left exposed, saturated, damaged, or adversely affected by the Contractor’s work.

3.19 WET WEATHER EARTHWORK

A. Some areas of the site contain soils that are highly moisture sensitive. These soils may become unstable and unsuitable when allowed to become wet.

B. Onsite soils shall not be used for structural fill during wet weather periods. Fill materials placed during wet weather shall be Imported Structural Fill.

C. Slope the ground surface within and surrounding the construction area to promote runoff away from work areas and to prevent ponding of water.

D. Work areas should be covered with plastic to protect from rainfall. Measures such as sloping, ditching, dewatering, and installation of pumps and temporary storage tanks shall be employed.

E. Earthwork should be accomplished in small sections to minimize exposure to wet conditions. Each section should be small enough so that the removal of unsuitable soil and placement and compaction of structural fill can be accomplished on the same day.

F. Do not leave soil uncompacted and exposed to moisture. A smooth-drum vibratory roller, or equivalent, shall roll the surface to seal out as much water as possible.

G. Limit areas of exposed soil during periods of wet weather.

H. In-place soil or fill soil that becomes unsuitable for compaction shall be removed and replaced with Imported Structural Fill.

I. Grading and earthwork shall not be performed during wet weather periods or heavy, continuous rainfall.

3.20 BACKFILLING UTILITY TRENCHES

A. Place and compact pipe bedding on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, fitting, and barrels of pipes and conduits.

B. Place and compact initial and final backfill as identified on the drawings. Backfill shall be free of particles larger than 1 inch, within 6 inches above the crown of the utility pipe or conduit. Backfill shall consist of Onsite Structural Fill or Imported Structural Fill as defined in these specifications.

   1. Carefully compact material under pipe haunches and bring backfill evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of utility system.
   2. Trench backfill shall be compacted to at least 95 percent of maximum dry density based on ASTM D1557.

C. Cobbles, boulders, or weathered bedrock shall not be used for trench backfill.

D. Coordinate backfilling with utilities testing.

E. Fill voids with approved backfill materials while shoring, bracing, and sheeting is removed.

F. Provide locating wire directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs. The ends of locate wire shall be exposed and maintained.

G. Arrange for and provide detectable warning tape on top of utility trench of specified color for particular utility.

H. Conform to City of Kenmore standards for all work within City right-of-way.

I. Conform to requirements specific to utility purveyors including Northshore Utility District, Puget Sound Energy, Verizon, and Comcast for each respective utility construction.

3.21 GRADING

A. Rough grade all areas to subgrades shown on plans, to reasonably true smoothness, free from non-uniform levels or slopes. Roll or round cut and fill surfaces at abrupt changes in elevation. At this point, Geotechnical and Civil Engineers and Landscape Architect shall inspect the subgrades of building pads, pavement areas, and landscaped areas to determine that the design intent shown on the plans has been accurately achieved. The Contractor shall make arrangements for the Geotechnical and Civil Engineers and Landscape Architect to observe grading work and obtain approval of subgrade prior to any additional work.

B. Finish Grading: Grade entire area shown on the plans to a smooth, even surface. Remove stones larger than 2 in. in size, and all sticks and twigs. Grade to uniform slopes with no dishes or depressions except as shown on plans. Finish grading shall be within +/- 1/2 in. of grades shown on plan or specified herein.

C. Inspection and Testing: Geotechnical Engineer shall inspect grading work at least daily when grading is in progress and make as many tests as necessary to assure complete and uniform compaction of subgrade.

D. Provide temporary slopes and temporary shoring walls as necessary to allow phased construction.

3.22 CRUSHED SURFACING

A. Under pavements and walks, place crushed surfacing on prepared subgrade and as follows:

1. Place crushed surfacing material over approved subgrade.
2. Compact crushed surfacing at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.
3. Shape crushed surfacing to required crown elevations and cross-slope grades.
4. When thickness of compacted crushed surfacing is 6 inches or less, place materials in a single layer.
5. When thickness of compacted crushed surfacing exceeds 6 inches, place materials in equal layers, with no layer more than 6 inches thick or less than 3 inches thick when compacted.

B. Pavement Shoulders: Construct shoulders to prevent lateral movement. Construct shoulders at least 12 inches wide, of specified structural fill materials and compact simultaneously with each crushed surfacing layer to not less than 95 percent of maximum dry unit weight according to ASTM D1557.

3.23 TOLERANCES

A. Top Surface of Subgrade:

1. Building foundations and slab-on-grade: Plus or minus 0.05 foot.
2. Concrete Walks and ACP: Plus or minus 0.05 foot.
3. Landscaped Areas: Plus or minus 0.10 foot.

B. Any work that is determined not to conform shall be reworked by the Contractor to bring into conformance at the Contractor's expense.

3.24 FIELD QUALITY CONTROL

A. Field inspection and testing shall be performed under provisions of Division 1 Section 014000 “Quality Control.”

B. Compaction testing of in-place soils shall be performed in accordance with ASTM D2922. Maximum dry density shall be determined in accordance with ASTM D1557.

C. Notify and allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.

D. Footing Subgrade: Verification and approval of footing subgrades shall be completed by the Geotechnical Engineer.

E. Geotechnical Engineer or testing agency will test compaction of soils in place according to ASTM D 1556, and ASTM D 2922, as applicable. The Contractor shall obtain tests at the following locations and frequencies:

1. Building Slab-on Grade: At each compacted fill and backfill layer, at least one test for every 500 sq. ft. or less of slab area, but in no case fewer than three tests.

2. Asphalt Pavement and Concrete Areas: At each compacted fill and backfill layer, at least one test for every 1,000 sq. ft. or less of paved area, but in no case fewer than three tests.
3. Foundation Wall Backfill: For each 2 vertical feet of fill placed, at least one test for each 100 feet, or less of wall length, but no fewer than two tests.
4. Trench Backfill: For each 2 vertical feet of trench backfill placed, at least one test for each 100 feet, or less of trench length, but no fewer than one test.
5. Utility Structures: No less than one compaction test adjacent to each structure.

F. When the Geotechnical Engineer or testing agency reports that subgrades, fills, or backfills have not achieved the degree of compaction specified, the Contractor shall scarify and moisture condition, or remove and replace soil to depth required, recompact and retest until specified compaction is obtained at no additional cost to the Owner.

G. If tests indicate Work does not meet specified requirements, remove Work, replace and retest, or survey at Contractor’s expense.

H. For additional requirements, see Section 014000 “Quality Control.”

I. Any work that is determined to be nonconforming shall be reworked by the Contractor to bring into conformance at the Contractor'sexpense.

3.25 PROTECTION OF FINISHED WORK

A. Protect Graded Areas: Protect newly-graded areas from traffic, freezing, ponding water and erosion. Keep free of trash and debris. Protection of foundation or utility trench excavations should include tenting with plastic sheeting as necessary to perform the work.

B. Repair and re-establish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

1. Scarify or remove and replace soil material to depth as directed by Geotechnical Engineer; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional approved soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to the greatest extent possible.

D. Erosion control measures shall remain in place until entire site is stabilized and approved by the City and Owner.

E. Protect exposed soils according to erosion and sediment control requirements and these specifications.

F. When site soils are exposed or used as fill, they shall be protected due to their moisture sensitive nature. Contractor shall be responsible to take whatever measures necessary to protect subgrades from damage. Protection measures shall be approved by the Geotechnical Engineer. Protection measures are a part of the Base Bid Contract Work.

G. Repair and re-establish grades in settled, eroded, rutted, or otherwise damaged areas. In damaged compacted areas, scarify surface, re-shape, and compact to required density prior to further construction. This work shall be completed by the Contractor at no additional cost to the Owner.

3.26 STORAGE OF CONSTRUCTION MATERIALS

A. All liquid construction materials shall be stored under cover in containers with lids and placed in a shallow plastic tub or equivalent for spill containment.

3.27 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Promptly remove stripped topsoil, unsatisfactory soil, trash, debris, and surplus soils, and legally dispose of it off Owner's property at a permitted location.

B. Surplus soil: Excess excavated soil and fill must be disposed of off Owner's property. Disposal of soil resulting from trench excavations for foundations, utilities and irrigation is included in the work. Surplus soil material shall be immediately removed from the site.

END OF SECTION 312000

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Work of this section includes, but is not limited to, the following:

1. Hot Mix Asphalt (HMA) paving and patching.
2. Asphalt Treated Base (ATB).
3. Asphalt Sealcoat of Existing Parking Lot.

B. Related Sections include the following:

1. Section 312000, "Earth Moving" for trenching, bedding, backfill and crushed rock surfacing.

1.3 REFERENCE STANDARDS

A. Washington State Department of Transportation Standard Specifications for Road, Bridge and Municipal Construction, latestedition.

B. Washington State Department of Transportation Standard Plans for Municipal Construction, latest edition.

C. City of KenmorePublic Works Standards.

1.4 SUBMITTALS

A. Submit under provisions of Division 01 Section 013300, "Submittal Procedures" and as further provided.

B. Submittals that have been submitted and approved shall be available onsite for reference by the Owner and Engineer.

C. Submit test results and reports.

D. Certification:

1. Provide a letter, signed by the supplier and reviewed and also signed by an officer of the General Contractor's company, certifying that all products to be incorporated into the work meet the requirements specified.
2. All product submittals shall be submitted to the Engineer for review and approval. Asphalt paving construction shall not commence until all submittals have been approved by the Engineer.
3. Products:
   a. Asphalt Concrete Paving
   b. Asphalt Paving Joint Sealer
   c. Asphalt Treated Base
   d. Asphalt Paving Tackcoat

e. Asphalt Sealcoat

1.5 PROJECT CONDITIONS

A. Existing Paving and Surfacing: Contractor shall take care in protecting pavement and walks intended to remain. The Contractor shall replace any existing sidewalks or concrete curbs that are damaged during construction at their own expense.

B. Demolished materials shall be completely removed from the project site and disposed of at an approved location.

C. Geotechnical reports of subsurface condition investigations made during the Project design are available for informational purposes only; data in these reports are not intended as representations or warranties of accuracy or continuity of conditions between field investigation points (i.e. soil borings, test pits, etc.). Owner assumes no responsibility for interpretations or conclusions drawn from this information.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced installer who has completed hot-mix asphalt paving similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

B. Perform work in accordance with WSDOT Specifications.

C. Mixing Plant: Conform to WSDOT Specification 5-04.3.

D. Obtain materials from same source throughout.

E. Equipment: Conform to WSDOT 5-04.3(2). Steel wheel rollers shall have a minimum weight of 10 tons except for rollers used to compact areas inaccessible to a 10 ton roller.

F. Owner will employ the services of an independent inspection and testing service to conduct inspections and tests specified in this Section.

G. Maintain one copy of WSDOT Specification and the project plans and specifications on site.

1.7 REGULATORY REQUIREMENTS

A. Conform to applicable codes for materials and installation of the Work of this section. Codes include, but are not limited to, the following:

1. WISHA (Washington Industrial Safety and Health Act).
2. Local codes for work on public or private property.
3. MUTCD for pavement markings and traffic signs.

B. Conform to City of Kenmore requirements for all work performed within the public right of way.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Environmental Limitations: Do not apply HMA materials if substrate is wet, excessively damp, or if the following conditions are not met:

1. Prime and Tack Coats: Minimum ground surface temperature of 50 degrees F.
2. Asphalt Surface Course: Minimum surface temperature at time of placement complies with WSDOT Specification 5-04.3(16).
3. Asphalt Base/Top Course: Minimum surface temperature at the time of placement complies with WSDOT Specification 5-04.3(16).

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Use materials and gradations that have performed satisfactorily in previous installations.

B. Asphalt Treated Base: Conform to WSDOT Specifications 4-06 and WSDOT 9-02.1 and 9-03.6.

C. Hot Mix Asphalt Materials: HMA conforming to WSDOT Specification 5-04. For onsite asphalt paving, use HMA ½" Asphalt Concrete per WSDOT 9-03.8(6).

D. Sand: ASTM D 1073, Grade Nos. 2 or 3.

E. Joint Sealer: Shall be paving asphalt viscosity grade AR-4000 W or CSS-1.

F. Tackcoat: CSS-1 Cationic Emulsion Asphalt per WSDOT 9-02.1(6).

G. Asphalt Sealcoat: This work shall consist of two applications of a modified asphalt sealcoat on the bituminous pavement shown on the plans. The seal coat material shall be an asphalt emulsion blended with selected fibers, granular fillers, pigments and polymer additives meeting the following requirements:

	Limits
Flow Table Consistency, 1/8" drop/inch (ASTM C-124)	5.5 to 7.5
Residue, % of weigh (ASTM D-2939)	60 MIN.
Weight per Gallon, Lbs. (ASTM D-244)	10.5 min.
Mineral Aggregate (% passing No. 20 sieve)	100%

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify compacted subgrade is dry and ready to support paving and imposed loads. Verify that subgrade has been inspected by the Geotechnical Engineer, and gradients and elevations are correct. Proof roll subgrade as required.

B. Notify Architect in writing of any unsatisfactory subgrade conditions identified by the Geotechnical Engineer. Do not begin paving until unsatisfactory subgrade conditions have been corrected and approved by the Geotechnical Engineer.

C. Do not begin any paving until the subgrade has inspected and approved by the Geotechnical Engineer.

3.2 SURFACE PREPARATION

A. Immediately before placing asphalt pavement, remove loose and deleterious material from surfaces to receive the pavement. Contractor shall ensure that prepared subgrade is ready to receive paving.

1. All utility trench cuts through the ATB shall be patched before final pavement lift is applied.
2. Sweep loose granular particles from surface of unbound-aggregate base course. Do not dislodge or disturb aggregate embedded in compacted surface of base course.
3. At areas of asphalt treated base or previous pavement lifts, the surface of ATB or pavement shall be cleaned and/or washed to remove dust and/or other objectionable material.
4. Tack coat shall be applied to ATB and allowed to dry immediately before paving.

B. Use hand tamping equipment in areas where inaccessible to large compaction equipment. Hand tamping equipment shall be flat bottomed and weighing a minimum of 40 pounds.

C. Tack Coat:

1. Apply CSS-1 cationic emulsified asphalt to all existing paved surfaces.
2. Application rate: 0.15 gallons retained asphalt per square yard. Adjust rate as directed by Architect.

3.3 HOT-MIX ASPHALT PLACEMENT

A. Spreading and Finishing: Conform to WSDOT 5-04.3(9).

B. Machine place hot-mix asphalt mix on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.

C. Place hot-mix asphalt in equal lift thicknesses with no lift thickness less than 1¼ inch compacted thickness. Maximum lift thicknesses shall not exceed compacted thicknesses shown in WSDOT Specification 5-04.3(10).

D. Conform to construction requirements in WSDOT Specification 5-04.

E. Place paving in consecutive strips not less than 10 feet wide, except where infill edge strips of a lesser width are required.
1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete asphalt base course for a section before placing asphalt surface course.

F. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.4 JOINTS

A. Construct joints to ensure continuous bond between adjoining paving sections. Construct joints free of depressions with same texture and smoothness as other sections of hot-mix asphalt course.

1. Clean contact surfaces and apply tack coat.
2. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.

3.5 PATCHING AND REPAIRS

A. Patching: Neatly saw cut perimeter of patch and excavate existing pavement section to sound base. Recompact new subgrade. Excavate rectangular or trapezoidal patches, extending 12 inches into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically.

1. Tack coat faces of excavation and allow to cure before paving.
2. Fill excavation with hot-mix asphalt and, while still hot, compact flush with adjacent surface.

B. Leveling Course: Install and compact leveling course consisting of dense-graded, hot-mix asphalt surface course to level sags and fill depressions deeper than 1 inch in existing pavements.
1. Install leveling wedges in compacted lifts not exceeding 3 inches thick.

C. Crack and Joint Filling: Remove existing filler material from cracks or joints to a depth of ¼ inch. Refill with asphalt joint-filling material to restore watertight condition. Remove excess filler that has accumulated near cracks or joints.

D. Tack Coat: Apply uniformly over and on edges of previously constructed asphalt or portland cement concrete paving and to surfaces abutting or projecting into new, hot-mix asphalt pavement. Apply at a uniform rate of 0.05 to 0.10 gal./sq. yd of surface.

1. Allow tack coat to cure undisturbed before paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spills and clean affected surfaces.

3.6 ASPHALT SEALCOAT

A. Surface must be clean and free from all loose material and dirt.

B. Clean and repair existing cracks.

C. Application of the seal coat material shall be by a mechanized, self-propelled squeegee machine or spray on applicator. Use of a hand squeegee shall be allowed in restricted or confined areas. Application shall be in accordance with the manufacturer’s recommendations. The sealcoat product shall be applied at the minimum rate of 0.35 gallons per square yard (undiluted material) in two separate applications. Approximately 65% of the total material shall

be applied with the first application and shall contain 1.5 pounds of No. 30 silica sand per gallon. Allow first coat to dry thoroughly before applying second coat.The second application (approximately 35 % of the total material) shall utilize seal coat material as furnished by the manufacturer.

D. Equipment used to apply the sealcoat shall have continuous agitation or mixing capabilities to maintain homogeneous consistency of pavement sealer mixture throughout the application process. Spray equipment shall be capable of mixing and spraying pavement sealer with sand added. Self-propelled squeegee equipment with mixing capability shall have at least 2 squeegee or brush devices (one behind the other) to assure adequate distribution and penetration of sealer into pavement surface. Hand squeegees and brushes shall be acceptable in areas where practicality prohibits the use of mechanized equipment.

E. Ridges of material shall not be allowed where adjoining applications overlap. Any overlap onto curbs, valve boxes, catch basin/manhole grates and frames and buildings shall be removed at the Contractor's expense.

F. The seal coat shall be applied only when the surface temperature of the pavement is 55 degrees fahrenheit or above and if rain is not forecasted for the period of 24 hours after application.

G. Random samples may be taken from the sealcoat machine to check dilution of the seal coat material. If the diluted product is found to be less than 45% solids, as determined by a hot-plate residue test, the Contractor shall reseal the area represented by a given sample at his/her expense.

3.7 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or vibratory-plate compactors in areas inaccessible to rollers.

1. Complete compaction before mix internal temperature cools to 175 degrees F.

B. Breakdown Rolling: Accomplish breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Repair surfaces by loosening displaced material, filling with hot-mix asphalt, and rerolling to required elevations.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling, while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:

1. Average Density: 96 percent of reference laboratory density according to ASTM D1559, but not less than 94 percent nor greater than 100 percent.
2. Average Density: 92 percent of reference maximum theoretical density according to ASTM D2041, but not less than 90 percent nor greater than 96 percent.

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while still hot, with back of rake or smooth iron. Compact thoroughly using tamper or other satisfactory method.

F. Repairs: Remove paved areas that are defective or contaminated with foreign materials. Remove paving course over area affected and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.

G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

I. Conform to the construction requirements in WSDOT Specification 5-04.3.

3.8 INSTALLATION TOLERANCES

A. Thickness: Compact each course to produce the thickness indicated within the following tolerances:

1. Base Course: Plus or minus 1/2 inch.
2. Surface Course: Plus 1/4 inch, no minus.

B. Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:

1. Base Course: 1/4 inch.
2. Surface Course: 1/8 inch.
3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is ¼ inch.

C. Asphalt surface shall not allow ponding of water to exceed 1/8 inch depth or encompass a surface area greater than 10 square feet.

D. Correction of Defective Work: Conform to applicable provisions of the Contract Documents. Contractor shall correct defective work to the satisfaction of the Architect at no additional cost to the Owner.

E. Positive Drainage: Positive drainage is required for all paved areas regardless of any information shown on the drawings or specified herein. Notify Architect of any areas where positive drainage cannot be achieved. Positive drainage is achieved when water drains off paved areas within 30 minutes without ponding. Asphalt surface shall not allow ponding of water to exceed 1/8 inch depth or encompass a surface area greater than 5 square feet.

F. Conform to WSDOT Specification 5-04.3(13).

3.9 PROTECTION

A. Protect unfinished Work from any disturbance.

B. Protect all conduits, pipe and aggregate cover from damage or displacement.

C. Protect existing bench marks and survey monuments from damage during construction.

3.10 ADJUST UTILITIES

A. Adjust manhole ring and cover, water valve lids, cleanouts and other utility surface features to be flush with finish grade of new pavement.

B. Adjustment of utility surface features will be necessary to allow for phased construction of various improvements. Contractor shall plan for adjusting utility surface features at different phases to protect the utility and/or allow the utility purveyor to perform inspections and allow use of the utility.

3.11 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing agency to perform field inspections and tests and to prepare test reports. See Section 014000, “Quality Control” for additional information.

1. Testing agency shall conduct and interpret tests and state in each report whether tested Work complies with or deviates from specified requirements.
2. Conduct nuclear density gauge testing in conformance with WSDOT 5-04.3(10)B.

B. Contractor shall comply with the requirements of the Owner's testing and inspection agency. Field inspection and testing shall be performed under provisions of the Project Manual.

C. Replacement of Defective Work: Replace all new paving which does not achieve positive drainage or is otherwise defective. Patching is not acceptable.

D. Additional testing, at Contractor's expense, shall be performed to determine compliance of corrected Work with specified requirements.

E. Thickness: In-place compacted thickness of hot-mix asphalt courses shallbe determined according to ASTM D3549.

F. Surface Smoothness: Finished surface of each hot-mix asphalt course shall be tested for compliance with smoothness tolerances.

G. In-Place Density: Samples of uncompacted paving mixtures and compacted pavement shall be secured by testing agency according to ASTM D979.

1. Reference laboratory density shall be determined by averaging results from 4 samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D1559, and compacted according to job-mix specifications.
2. Reference maximum theoretical density shall be determined by averaging results from 4 samples of hot-mix asphalt paving mixture delivered daily to site, prepared according to ASTM D2041, and compacted according to job-mix specifications.
3. In-place density of compacted pavement shall be determined by testing core samples according to ASTM D1188 or ASTM D2726.
    a. One core sample shall be taken for every 1000 sq. yd. or less of installed pavement, but in no case shall fewer than 3 cores be taken.

b. Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D2950 and correlated with ASTM D1188 or ASTM D2726.

H. Remove and replace hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

I. Sweep and clean pavement surface to eliminate loose material and dust.

END OF SECTION 321216

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. In general, work of this Section includes, but is not necessarily limited to, the following:

1. Cement concrete pavements.
2. Cement concrete walks.
3. Cement concrete curbs.
4. Cement concrete wheel stops.

B. Related Sections include the following:

1. Section 312000, "Earth Moving" for trenching, bedding, backfill and crushed surfacing.
2. Section 321216, “Asphalt Concrete Paving”.

1.3 REFERENCE STANDARDS

A. Washington State Department of Transportation Standard Specifications for Road, Bridge and Municipal Construction, latestedition.

B. Washington State Department of Transportation Standard Plans for Municipal Construction, latest edition.

C. City of KenmorePublic Works Standards.

D. ICC/ANSI A117.1-2003: Accessible and Usable Buildings and Facilities.

1.4 SUBMITTALS

A. Submit under provisions of Division 1 Section 013300, "Submittal Procedures" and as further provided.

B. Submittals that have been submitted and approved shall be available onsite for reference by the Owner and Engineer.

C. Certification:

1. Provide a letter, signed by the supplier and reviewed and also signed by an officer of the Contractor's company, certifying that all products to be incorporated into the work meet the requirements specified.
2. All product submittals shall be submitted to the Engineer for review and approval. Cement Concrete Paving construction shall not commence until all submittals have been approved by the Engineer.
3. Products:
   a. Cement concrete for pavements, curbs, and walks as described on the plans and details.

b. Cement concrete wheel stops.

1.5 PROJECT CONDITIONS

A. Existing Paving and Surfacing: Contractor shall take care in protecting pavement and walks intended to remain. The Contractor shall replace any existing sidewalks or concrete curbs that are damaged during construction at their own expense.

B. Demolished materials shall be completely removed from project site and disposed of at an approved location.

C. Geotechnical reports of subsurface condition investigations made during the Project design are available for informational purposes only; data in these reports are not intended as representations or warranties of accuracy or continuity of conditions between field investigation points (i.e. soil borings, test pits, etc.). Owner assumes no responsibility for interpretations or conclusions drawn from this information.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced installer who has completed concrete surfacing similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

B. Perform work in conformance with WSDOT Specification.

C. Conform to City of Kenmore standards and requirements.

D. Mixing Plant: Conform to WSDOT Specification.

E. Obtain materials from same source throughout.

F. Maintain one copy of WSDOT Specification and the project plans and specifications on site.

1.7 REGULATORY REQUIREMENTS

A. Conform to applicable codes for materials and installation of the Work of this section. Codes include, but are not limited to, the following:

1. WISHA (Washington Industrial Safety and Health Act).
2. Local codes for work on public or private property.

B. Conform to City of Kenmore requirements for all work performed within public rights-of-way.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Use materials and gradations that have performed satisfactorily in previous installations.

B. Sand: ASTM D 1073, Grade Nos. 2 or 3.

C. Cement Concrete Wheel Stops: Per plan.

D. Cement Concrete for Pavements, Curbs and Walks:

1. Conform to WSDOT 8-14 and 9-01 for Class 3000 for Portland Cement Concrete walks.
2. Conform to WSDOT 8-04 and 9-01 for Class 3000 for Portland Cement Concrete curbs.
3. Conform to WSDOT 5-05 and 9-01 for Class 4000 for Portland Cement Concrete pavement and walks subject to vehicular traffic and as specified on the plans.
4. Conform to Landscape Architecturalplans for control joint locations and special finishes of concrete walks and pavements.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS AND SURFACE PREPARATION

A. In general, all concrete pavements, curbs, and walks shall be constructed in accordance with WSDOT 5-05, 8-04, 8-14, respectively.

B. All concrete pavements, curbs, and walks shall be constructed in accordance with WSDOT and City of Kenmore standards within their respective right-of-ways.

C. Contractor shall verify that compacted subgrades and/or gravel bases have been inspected and approved by the Geotechnical Engineer and City Inspector. Verify that formwork and gradients and elevations are correct.

D. Notify Architect in writing of any unsatisfactory conditions identified by the Engineer and/or City Inspector. Do not begin formwork for concrete paving improvements until unsatisfactory conditions are corrected by the Contractor and approved by the Engineer and/or City Inspector.

E. Contractor shall allow the WSDOT/City Inspector to inspect and approve all formwork for curbs and paving before concrete is poured.

F. Notify Architect minimum 48 hours prior to commencement of placing concrete.

3.2 FORMING

A. Place and secure forms to correct location, dimension, and profile.

B. Straight forms shall not be used to form curves.

C. Assemble form work to permit easy stripping and dismantling without damaging concrete.

D. Place joint filler vertical in position, in straight lines. Secure to form work during concrete placement.

3.3 JOINTS

A. Place expansion and contraction joints as indicated on the Drawings. Align curb, gutter, and sidewalk joints.

B. Place joint filler between paving components. Recess top of filler 1/4 inch.

C. Control Joints: As shown on Drawings. Control joints shall be tooled with a standard tool to a depth equal to at least 1/4 the thickness of the pour. Tool shall leave rounded edges and shall completely separate aggregate the full depth of the joint.

D. Construction Joints: Plan execution of work so that construction joints occur at predetermined joint locations.

3.4 CONCRETE PLACEMENT

A. Inspection: Before placing concrete, inspect and complete formwork installation, reinforcement steel, and items to be embedded or cast in. Notify other trades to permit installation of their work.

B. Remove snow, ice, or frost from subbase surface and reinforcement before placing concrete. Do not place concrete on frozen surfaces.

C. Moisten subbase to provide a uniform dampened condition at the time concrete is placed. Do not place concrete around manholes or other structures until they are at the required finish elevation and alignment.

D. Comply with requirements and with recommendations in ACI 304R for measuring, mixing, transporting, and placing concrete.

E. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

F. Consolidate concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use equipment and procedures to consolidate concrete according to recommendations in ACI 309R.

G. Where reinforcing steel is used, steel shall not be permitted to move during concrete placement. Steel reinforcement shall be tied and supported according to WSDOT Specifications 6-02.3(24).

H. Screed pavement surfaces with a straightedge and strike off. Commence initial floating using bull floats or derbies to form an open-textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading dry-shake surface treatments.

I. Curbs and Gutters: When automatic machine placement is used for pavement, submit revised mix design and laboratory test results that meet or exceed requirements. Produce pavement to required thickness, lines, grades, finish, and jointing as required for formed pavement.

J. Slip-Form Pavers: When automatic machine placement is used for pavement, submit revised mix design and laboratory test results that meet or exceed requirements. Produce pavement to required thickness, lines, grades, finish, and jointing as required for formed pavement.

1. Compact subbase and prepare subgrade of sufficient width to prevent displacement of paver machine during operations.

K. When adjoining pavement lanes are placed in separate pours, do not operate equipment on concrete until pavement has attained 85 percent of its 28-day compressive strength.

L. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When air temperature has fallen to or is expected to fall below 40 degrees F (4.4 degrees C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 degrees F (10 degrees C) and not more than 80 degrees F (27 degrees C) at point of placement.
2. Do not use frozen materials or materials containing ice or snow.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators, unless otherwise specified and approved in mix designs.

M. Hot-Weather Placement: Place concrete according to recommendations in ACI 305R and as follows when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90 degrees F (32 degrees C). Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Cover reinforcement steel with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
3. Fog-spray forms, reinforcement steel, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.5 CEMENT CONCRETE WALKS

A. Cement Concrete Walks

1. Conform to Landscape Architectural plans for jointing details and finishes.
2. Conform to WSDOT specification section 8-14.
3. Provide joint control and surface treatment as indicated on the plans.
4. Provide 2 percent transverse slope away from buildings unless otherwise indicated.

3.6 ADJUST UTILITIES

A. Adjust manhole ring and cover, water valve lids, and other utility lids to maintain finish grade of new pavement.

3.7 PROTECTION

A. Protect finished and unfinished Work from any disturbance and damage from equipment and other work.

B. Protect all conduits, pipe and aggregate cover from damage or displacement.

C. Protect existing survey bench marks and survey monuments from damage during construction. Survey monuments that are damaged during performance of the Work shall be replaced at the Contractor’s expense.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Owner may engage a qualified independent testing agency to perform field inspections and tests and to prepare test reports.

1. Testing agency will conduct and interpret tests and state in each report whether tested Work complies with or deviates from specified requirements.

B. Additional testing, at Contractor's expense, will be performed to determine compliance of corrected Work with specified requirements.

C. Observations: Notify Architect at the following points during the progress of the Work. No subsequent Work shall be executed until Architect has had the opportunity to observe the condition and status of the Work.

1. Forms: When forms, base material, and embedded items are in place.

D. Conform to City inspection requirements.

E. Testing:
1. Testing Agency: Owner may engage a qualified independent testing agency to perform field inspections and tests and to prepare test reports.
2. Appointed testing agency will take cylinders and perform slump and air entrainment tests in accordance with ACI 301.
3. Three concrete test cylinders will be taken for every 100 or less cubic yards of each class of concrete placed each day.
4. One additional test cylinder will be taken during cold weather and cured on site under same conditions as concrete it represents.
5. One slump test will be taken for each load of concrete upon delivery. Perform air entrainment test with each slump test.

F. Contractor shall maintain records of placed concrete items. Record date, location of pour, quantity, air temperature, and test samples taken.

G. Positive Drainage: Positive drainage is required for all paved areas regardless of any information shown on the drawings or specified herein. Notify Architect of any areas where positive drainage cannot be achieved. Positive drainage is achieved when water drains off paved areas within 30 minutes without ponding except ponding of less than 1/8 inch over any 5 square foot area will be accepted.

H. Replacement of Defective Work: Replace all new paving which does not achieve positive drainage or is otherwise defective. Patching is not acceptable. Additional testing, at Contractor's expense, will be performed to determine compliance of corrected Work with specified requirements.

I. Sweep and clean finished surfaces to eliminate debris, loose material, and dust.

END OF SECTION 321313

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

Provisions of the Bidding Requirements, Conditions of the Contract, and Division 1 apply to all Sections of this Project Specification.

A. Work Included in This Section: Provide lines and symbols in parking lots, roadways, and other vehicular areas and miscellaneous pavement markings as indicated on the drawings and specified herein. Contractor provided pavement markings include crosswalk striping, parking stall striping, traffic signs/markings, and right of way channelization within the project site and on public roads.

B. Refer to the following sections for related work:

321216 for Asphalt Paving.
321313 for Concrete Paving, Curbs, and Walks.

1.3 REFERENCES

Listed publications form a part of this Section to the extent indicated by references.

A. WSDOT: Standard Specifications for Road, Bridge, and Municipal Construction, latest edition, by Washington State Department of Transportation and American Public Works Association, Section 8-22.

B. WSDOT: Qualified Product List (QPL)

1.4 SUBMITTALS

Refer to Section 013300 for general submittal requirements.

A. Certificate of Compliance: Submit certification by the materials and mix producers indicating that the materials and mixes are in compliance with these specifications. Certification shall be signed by the material and mix producers.

B. Product Data: Submit product data for paint.

C. Manufacturer's printed installation and/or application instructions as required.

1.5 QUALITY ASSURANCE

Conform to WSDOT as applicable and as referenced herein. Conform to City of Kenmore and MUTCD standards and requirements for pavement markings.

1.6 DELIVERY STORAGE AND HANDLING

Comply with manufacturer's instructions.

1.7 PROJECT CONDITIONS

A. Conform to manufacturer's requirements for items being installed and materials being used.

B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 degrees F for oil-based materials, 50 degrees F for water-based materials, and not exceeding 95 degrees F.

PART 2 – PRODUCTS

2.1 MATERIALS (WSDOT - QPL Listed)

A. Paint: Traffic Paint shall be one of the following approved paints:

1. Rodda Paint Company – Standard White I.D. 7371,
Yellow I.D. No 7372, 7382
2. Ennis Paint Company – Norline – White I.D. No. 984761/ HW8W1; Yellow I.D. No. 984761/ HW8Y2
3. Or Approved Equal

B. Pavement Markings: Paint materials shall conform to WSDOT 9-34.2. White, yellow, red, and blue colors to be used.

C. ADA Parking Symbol: Conform to Chapter 7 of the ICC/ANSI A117.102003.

D. Contractor shall provide fire lane markings as required by the City of Kenmore Fire Marshal. Contractor shall coordinate fire lane markings accordingly.

E. Thermoplastic Pavement Marking: Conform to WSDOT 9-34.3(1) or 9-34.3(2). Color shall be white. Provide thermoplastic pavement markings within the public right of way as required by the City of Kenmore and WSDOT. Provide painted pavement markings for pedestrian crosswalks and stop bars within the school site.

F. Traffic and ADA Signs: Signs shall conform to the Manual on Uniform Traffic Control Devices “MUTCD” and “Washington State Sign Fabrication Manual.”

1. Posts shall be 2-inch square galvanized steel with concrete foundation.

2. Sign shall be of sheet aluminum with Type 3 or 4 reflective sheeting conforming to WSDOT 9-28.12.
3. Sign color, message, font and symbols shall conform to MUTCD for standard traffic signs.

PART 3 - EXECUTION

3.1 PREPARATION

A. Verify that pavement construction is complete, approved, and is ready for work of this Section. Start of Work shall indicate Contractor's acceptance of existing conditions.

B. Do not apply pavement marking paint until layout colors and placement have been approved by the Architect.

C. Allow asphalt paving to cure for 30 days before applying pavement markings.

D. Within 24 hours before applying pavement markings, sweep and clean pavement surface to eliminate loose material and dust.

E. Apply double coat of all painted lines.

F. Striping: Use chlorinated-rubber based traffic lane-marking paint, factory mixed, quick-drying, and non-bleaching.

G. Apply paint with mechanical equipment to produce markings of dimensions indicated with uniform straight edges. Apply in two coats at manufacturer's recommended rates to provide a minimum wet film thickness of 25 mils.

H. ADA Parking Symbol shall conform to Chapter 7 of the ICC/ANSI A117.102003.

I. Conform to WSDOT Specification 8-22.

J. Contractor shall layout preliminary spotting for review by the Architect prior to start of marking pavement. Preliminary spotting shall be at appropriate frequency to allow Architect to determine conformance of layout. Prepare surfaces in accordance with Manufacturer's printed instructions for material being applied.

3.2 APPLICATION OF MARKINGS

A. Painted Markings: Two coats of paint line are required. Apply a minimum wet thickness of 10 mil (160 square feet per gallon) for the first coat. Apply minimum wet thickness of 15 mil (120 square feet per gallon) of specified paint for the second coat of paint. Apply paint with mechanical equipment to produce markings of dimensions indicated with uniform straight edges.

3.3 TRAFFIC SIGNAGE

A. Prior to installing the sign post, provide a stake in the ground at proposed location of the sign for review and approval by the Architect. The stake shall state the sign message, sign height and sign orientation.

3.4 FIELD QUALITY CONTROL

A. Observations: Notify Architect at the following points during the progress of the Work. No subsequent work shall be executed until Architect has observed the status and condition of the Work.

1. Preliminary spotting prior to pavement marking.
2. Completion of pavement marking operations.

B. Conform to City of Kenmore inspection requirements.

C. Tolerances: Conform to WSDOT 8-22 as applicable.

3.5 MARKING MATERIAL SCHEDULE

Unless otherwise indicated on the drawings, the following pavement markings apply:

A. Striping: White paint for 4 in. wide parking stripes and other lines as may be indicated. Other colors as required by code.

B. Directional Signs and Symbols: White paint for directional arrows and other markings and colors as may be indicated or as required by code.

C. Fire Lane Markings: Contractor shall coordinate and confirm colors, sizes, locations with the City of Kenmore Fire Marshal. Notify Architect immediately of any changes.

D. Thermoplastic Pavement Marking: Conform to WSDOT 9-34.3(1) or 9-34.3(2). Color shall be white. Provide thermoplastic pavement markings within the public right of way as required by City of Kenmore and WSDOT. Provide painted pavement markings for pedestrian crosswalks and stop bars within the school site.

END OF SECTION 321723

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Division 01 Specification Sections, apply to work of this Section.

1.2 DESCRIPTION OF WORK

A. Provide and install site furnishings and other site improvements as specified and shown on the drawings.

B. Provide District with complete facilities ready to use for regulation activities.

C. All work to conform to recommendations and guidelines of all applicable manufacturers, installers and associations, et al.

1.3 COLORS

A. As noted, or to be as selected by Architect from manufacturer’s complete line.

1.4 SUBMITTALS

A. Submit catalog cut sheets for all specified items and detailed shop drawings for all items requiring fabrication.

B. Submit installation procedure to Architect for approval prior to installation.

C. Submit source and representative photos of 2 specified boulder sizes.

PART 2 - PRODUCTS

2.1 LITTER RECEPTACLE

A. Manufacturer:

1. Landscape Forms, “Chase Park” side opening litter receptacle. Surface mount. “Titanium” powder coat color. Contact: Tim Gish, Landscape Forms NW, (502) 381-4964.

2.2 BICYCLE RACKS

A. Manufacturer:

1. Sportworks, (800) -661-0555, Tofino No Scratch Bike Rack. Stainless steel with protection pad. Quantity of racks as shown on Plans.

B. Install per manufacturer's instructions with tamper proof hardware secure to pavement. Stake or mark location for approval by landscape architect prior to installation.

2.3 PRECAST CONCRETE BENCHES

A. Reinforced concrete bench Item #Q-LEAF-B by 'QCP' (www.qcp-corp.com). Color and finish to be selected by Architect.

2.4 DETECTABLE PAVERS

A. Hanover Detectable Warning Paver, 12" square, charcoal color, as available at www.hanoverpavers.com.

2.5 BOLLARD TYPE A

A. Reliance Foundry Model #R-8902, Stainless Steel Bollard. Install as fixed embedded mount, and per manufacturer's recommendations.

PART 3 - EXECUTION

3.1 GENERAL

A. Refer to applicable details and plans for layout and installation.

B. Install rigid, plumb and true to lines and levels shown. Stake out all elements called for in this section for approval by Architect. All work of highest quality.

C. Unless otherwise indicated, install all products specified by name/manufacturer as per manufacturer's recommendations.

END OF SECTION 323000

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 work of this Section.

1.2 DESCRIPTION OF WORK

A. Include all labor, materials, equipment, transportation, and services to complete chain link fencing and gates as shown on the drawings and herein specified.

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Refer to Section 32 30 00, Site Improvements.

B. Refer to Section 32 1300, Concrete Pavement.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's literature including details of all component parts and installation details for the fence and gate installation.

1.5 STANDARDS

A. Industry Standards: Standard for Industrial Steel; Specifications for Fence Posts, Gates and Accessories; Standards for Chain Link Fence Installation; as published by Chain Link Fence Manufacturer's Institute (CLFMI), American Society for Testing & Materials (ASTM).

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: All new steel and iron parts; to be galvanized in accordance with CLFMI, ASTM, and as herein specified.
   1. Fabric: Hot-dip process after fabrication or fabricated from wire zinc-coated by the electrolyticor hot-dip process. Weight of zinc coating minimum average of 2.0 ounces per square foot complying with ASTM A392.
   2. Posts, rails, braces: Tubular members in accordance with ASTM A120, Schedule 40.
   3. Accessories: In accordance with ASTM A153.

2.2 FABRIC

A. Chain Link: No. 9 gauge, 8,000 psi tensile strength steel wire woven in 2" mesh. One-piece fabric in height, no splices, heights as noted on drawings.

B. Install sight obscuring HDPE "Solitube Slats" with "Viper Channel" locking system, black color at trash enclosure and any other area indicated on drawings. Install between chain link fabric per manufacturer's specifications. Available through Slat Depot, https://www.slatdepot.com/product/solitube-slats/

C. Selvage: Shall be knuckled on both selvages for all fabric.

2.3 POSTS

A. End Corner 4' and 6' fence heights: Steel pipe, 2-7/8 inch O.D., 5.79 lbs; 8' and 10' fence heights: Steel pipe, 4" O.D., 9.1 lbs.

B. Line 4' and 6' fence heights: Steel pipe, 2-3/8 inch O.D., 3.65 lbs; 8' and 10' fence heights: Steel pipe, 2-7/8" O.D., 5.79 lbs.

C. Swing Gate 30: Steel pipe. Single or one leaf of double gate width:

1. 5 feet or less: 2-7/8" O.D., 5.79 lbs.
2. 6 feet to 11 feet: 4" O.D., 9.1 lbs.
3. 12 feet to 18 feet: 6-5/8" O.D., 18.97 lbs.

F. Posts: All posts shall have standard pressed steel tops designed to fit posts and carry top rail; standard of manufacturer, ASTM F626.

2.4 TOP AND BOTTOM RAILS AND BRACES

A. Steel pipe, 1-5/8 inch O.D., 2.30 lbs. Couplings: 6 inch length each joint. Spring couplings, 1 coupling in 5. Form continuous brace, end-to-end of fence run.

2.5 GATE FRAMES (FOR ALL OPENINGS)

A. Galvanized Steel Pipe. No onsite welds. 1-7/8" O.D., 2.72 lb. per foot. Welding or fittings and rivets. Provide horizontal, diagonal and vertical members as required for rigidity. Provide truss rods where necessary. Gate shall support 300 lbs. imposed load at extreme and throughout entire range of operation without sag or damage.

B. Provide method for securing all gates in open position.

C. Latches: Install Fulcrom style latch for each gate, and hardware to accommodate heavy duty padlock. Install (1) drop rod assembly per gate frame for each gate 6' or longer, with accompanying hole in pavement to accept cane.

2.6 STRETCHER BARS

A. Steel: Galvanized. Minimum size 3/16 x 3/4". Provide one at each gate, end post, and gate frames end. Provide two at each corner and pull post. Bars not required for posts where mesh is woven into lock loops.

B. Stretcher Bar Bands: Regular pressed steel, galvanized, spaced evenly, 12" center maximum. Use off-set bands for all post sizes 4" and greater to provide a true fabric and rail alignment.

2.7 WIRE TIES

A. Wire: 9 gauge steel, with minimum of three (3) full wraps around each connection. Cut off protruding ends.

B. Application:
1. Line posts: 12" centers.
2. Rails and braces: 24" centers.
3. Tension Wire: 7 gauge hog rings, 24" centers.

2.8 TENSION WIRE

A. 7 gauge coil spring wire. Aluminum coated, class II 0.4 oz. ASTM A491.

2.9 CONCRETE

A. Refer to Section 32 13 13, Concrete.

2.10 LOCKS

A. Provide and install Knox weatherproof padlocks for all vehicular gates, Model # Knox 3770.

PART 3 - EXECUTION

3.1 GENERAL

A. In accordance with manufacturer's published instructions, ASTM F567 and herein specified.

B. Stake out or mark fence and gate locations for approval prior to digging footings and installation.

C. Set posts uniform in horizontal and vertical alignment, equally spaced, as indicated on drawings. Hold tops of all concrete footings at least 6" below finish grade.

D. Where fence is integral with concrete mow strip or sidewalk, hold top of footings at bottom of paving as detailed.

E. No post holes are to be left open or unguarded during installation.

F. Contractor shall familiarize himself with locations of all underground utilities including irrigation. Notify Landscape Architect of any conflict encountered.

G. Do not contaminate topsoil in seeded or planted areas with soil from post excavations. Use plastic sheeting or other measures to keep materials separated. Dispose of excess soils where directed.

3.2 POST FOUNDATIONS

A. Concrete
1. End, Corner (4’ and 6’ fencing): 12” hole diameter, 42” deep, 36” post embedment.
2. End, Corner (8’-10’ fencing): 12” diameter, 48” deep, 42” post embedment.
3. Line (4’ and 6’ fencing): 12” hole diameter, 36” deep, 30” post embedment.
4. Line (8’-10’ fencing): 12” hole diameter, 42” deep, 36” embedment.
5. Gate Post: 12” hole diameter, 42” deep, 42” post embedment.

3.3 PLACING CONCRETE

A. Place around posts in a continuous pour. Compact concrete by hand rodding.

B. Finish tops of concrete by hand trowel to provide a sloped dome 6” below finish grade unless noted otherwise; 1” slope from post.

C. Set keepers, stops, and sleeves in concrete. Minimum concrete coverage of items: 4” each side and 6” deeper than item.

D. Provide crack control joint at each post location.

3.4 FABRIC

A. Stretch fabric taut and tie to posts, braces, rails and frames. Fastenings to terminal posts shall be with stretcher bars and fabric bands. Fastenings to line posts shall be with tie wire. Fabric rolls shall be joined only at posts and by weaving a single strand of wire into the ends of the fabric to form a continuous mesh. Mesh shall have bottom tension wire.

B. Place fabric and tension wire so that maximum gap at bottom of fence is 1" from finish grade in any location.

C. Place fence fabric on play area side of posts. Request direction from Landscape Architect where necessary.

D. Bend all wire ties away from area of play. Ensure no sharp or dangerous protrusions.

3.5 CLEAN UP, ADJUSTMENTS

A. Remove excess earth resulting from post installations. Spread where directed.

B. Clean up all concrete spills from adjacent paving and earth. Clean all parts of concrete splatter and installation contaminants.

END OF SECTION 323113

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to work of this Section.

B. Refer to Section 320000, Planting.

1.2 DESCRIPTION OF WORK

A. The work of this Section includes but is not limited to the following:

1. Furnishing and installing automatic irrigation system including complete point of connection to water line, trenching, import bedding and backfill, and furnishing and installing all equipment and items noted on drawings and specified herein, and balancing and testing of system.

Note: Prior to bidding the work of this Section, Contractors shall visit the site to generally familiarize themselves with existing conditions, soils, slope, access, and other apparent site conditions.

1.3 QUALITY ASSURANCE

A. Codes and Ordinances: All local, municipal and State laws, rules, and regulation governing or relating to any portion of this work are hereby incorporated into and made a part of these specifications. Anything contained in these specifications shall not be construed to conflict with the above-mentioned rules, regulations or requirements, and where a conflict may occur, the rules regulations, or requirements of the governing code shall be adhered to. However, when these specifications and/or drawings call for or describe materials, workmanship or construction of a better quality, higher standard or larger size, these specifications and/or drawings shall take precedence over the requirements of said rules, regulations, or codes.

1.4 SUBMITTALS

A. Products and Materials: Immediately after award of contract, provide descriptive literature/information as to all operating characteristics, including operating pressures, pressure losses, materials used in product, test certificates, special features, etc., for those products not specified by manufacturer or those submitted for approval as equal. Only the Landscape Architect can accept an item as "equal". Approval must be in writing.

1.5 PERMITS AND FEES

A. Obtain all permits and pay required fees to any governmental agency having jurisdiction over the work. Arrange inspections during construction if required by local agencies and ordinances.

1.6 APPROVAL

A. Whenever the terms "approve" "approval" or "approved" are used in the Specification, they mean approval of Landscape Architect in writing.

1.7 RECORD IRRIGATION DRAWINGS

A. Contractor shall furnish record drawings of the complete irrigation system in accordance with the General and Special Conditions. The Landscape Architect shall provide two sets of full-size prints showing all irrigation work required under this contact. One set of prints is always to be on site during the construction so that Contractor can make a daily record of all work installed.

B. Actual location of hidden items including valves, stub cuts, manual drains shut-off valves shall be shown on the prints by dimensions from easily identified permanent features such as buildings curbs fences walks or property lines. Drawings shall show approved manufacturer's name and catalog number. The drawings shall be to scale and all indications shall be neat. These prints will be observed by the Landscape Architect throughout the course of work. After testing and approval of mainlines and laterals for cover-up all information noted on the job site prints shall be transferred to the final drawings with all indications recorded in a neat orderly way by Contractor. The record drawings shall be turned over to the Landscape Architect for review at or before the Provisional Acceptance (punch list) of the Project.

C. Operations Manual: One manual, bound in a hardback cover, shall be submitted to the architect for approval at the time of mainline testing. It shall include as a minimum the following information for all items used on the system:

1. List of authorized distributors and service representatives for each piece of irrigation equipment, including names, addresses, and phone numbers.
2. Guarantee/warranty certificates.
3. Instruction manuals.
4. Parts lists for each item with exploded views of each item showing part numbers.
5. Complete trouble-shooting guide to common irrigation problems.
6. DCVA Test Certification. Contractor shall arrange and pay for test by a Washington State certified backflow assembly tester.
7. Winterization and spring start-up procedures.

D. At the time of final inspection of the completed installation, the Contractor shall have completed revisions to the Landscape Architect's satisfaction of the "as-built" drawings and operations manual (indicating all changes) ready to turn over to the District for recording purposes; this shall be accomplished prior to final payment. Provide 3 copies to District.

1.8 JOB CONDITIONS

A. Water Source: Refer to Drawings, connect to stub out as shown on civil plans.

B. Power Source: 120 V.A.C. power for controller, as provided in electrical drawings.

C. Mechanical/Electrical:

1. Provide (1) 4” diameter schedule 40 conduit and (1) 1" conduit for control and antenna wiring from new controller location to outside planting area and roof as shown on drawings.

E. Sleeving: Sleeve under all paved areas, with PVC schedule 40 sleeves, size as shown on plans.

F. Other Trades: Coordinate all work with that of other trades.

G. Available Water Pressure: Verify available water pressure at point of connection prior to beginning work.

1.9 PROTECTION

A. Protect work, adjacent property, public, and be responsible for any damage or injury arising from this contract.

B. Confine work to areas designated. Do not disturb natural vegetation outside of project limit lines. Protect all trees within project limits not designated to be removed. Repair or replace vegetation damaged by Contractor's operations to satisfaction of District at Contractor's expense.

C. Be cognizant of all utility lines and underground obstruction. Be familiar with all utility, irrigation, mechanical, and electrical plans, so that digging/drilling operations do not damage lines. Replace or repair at Contractor's expense any existing buildings, equipment, underground utilities, walks, stairs, and/or forms damaged because of Contractor's operations in a manner satisfactory to the District before final payment is made.

1.10 GUARANTEE

A. Guarantee the satisfactory operation of equipment, materials and workmanship, including restoration of the area for a period of one year from the date of its acceptance. Repair or replace any defect in equipment or workmanship occurring within that year at Contractor's expense.

PART 2 - PRODUCTS

2.1 GENERAL

A. Materials: All materials to be incorporated in this system shall be new and without flaws or defects and of quality and performance as specified, and meeting the requirements of the system. All pipe damaged or rejected because of defects shall be removed from the site at the time of rejections.

B. Substitutions: No substitutions of smaller pipe sizes will be permitted but substitutions of larger sizes of same type at no extra cost with approval are acceptable.

C. Whenever any material is specified by name or number, such specifications shall be used for facilitating a description of the materials and establishing quality and shall be deemed and

construed to be followed by the words "or approved equal." No substitutions will be permitted which have not been submitted for prior written approval of the Landscape Architect.

2.2 PIPE AND FITTINGS

A. Polyvinyl Chloride Pipe and Fittings:

1. PVC Pipe and Fittings: PVC compound Type 1, Grade 1, or Type 1, Grade 2, conforming to ASTM D 1784 specifications and approved and certified by the National Sanitation Foundation, all fittings Schedule 40 unless otherwise noted. Each length of PVC pipe is to be marked with an identifying extrusion "run" number and the manufacturer's name or trade name, the pipe size and schedule or class.
2. PVC Solvent Weld Pipe: PVC 1120 and 1220 material, and shall have 200 psi minimum pressure rating unless otherwise indicated, with SDR 21 walls which conform to ASTM D 2241. PVC pipe with walls heavier than SDR 21 shall be installed when noted.
3. PVC Threaded Pipe PVC 1120 or PVC 1220 materials, Schedule 80 conforming to ASTM D 1785.
4. Plastic Pipe Fittings: Conform to ASTM D 2466, Type 1, Grades 1 or 2. Pipe may be belled on one end with the dimensions of the tapered bell conforming to ASTM D 2672. Molded fittings manufactured of the same materials as the pipe, suitable for solvent weld, unless otherwise specified. Slip fitting socket taper shall be so sized that a dry, unsoftened pipe end can be inserted no more than halfway into the socket. Plastic saddle and flange fittings not permitted.
5. Solvent Weld Compound: Two-step application, with primer and solvent compounds.

2.3 PIPE BEDDING & BACKFILL

A. Pipe bedding and backfill of irrigation trenches to subgrade elevation shall be with imported sand (maximum particle size 1/4”). Submit source and sample for approval.

2.4 IRRIGATION HEADS

A. As shown on drawings.

2.5 VALVES

A. Quick Coupler Valves: Brass, one-or two-piece with spring-loaded locking rubber cover. As shown on drawings.

B. Manual Drain Valves: Brass, 3/4" size, commercial quality, non-rising stem type, as shown on drawings.

C. Zone Valves: Electric remote-control valve as shown on drawings.

D. Master Valve: Normally closed electric control valve as shown on drawings.

2.6 VALVE BOXES AND PROTECTIVE SLEEVES

A. General: Enclose all valves and quick couplers in valve boxes, at depth of pipe. Provide extensions to finish grade as required.

B. Valve Boxes: As shown on drawings. Carson #1419-12, green, with flush, bolt down cover. Provide captive bolt and LOC-KIT, typical.

2.7 PROTECTIVE SLEEVE WITH LOCKING CAPS

A. 2"-diameter Class 160 PVC, length as required. Caps, Rainbird #63100. All drain valves and manual control valves to be enclosed in protective sleeves/locking caps.

2.8 VALVE KEYS AND VALVE BOX COVER KEYS

A. Provide two complete sets of all keys required for opening or operation of valves, valve box covers, and protective sleeve cap covers.

2.9 CONTROLLER

A. As indicated on plans. Irrigation contractor shall number each wire with zone number, common and spare indications.

B. Determine and coordinate the responsibilities of each trade prior to installation. Install conduit for wires per code and as noted on drawings.

2.10 MISCELLANEOUS ELECTRICAL EQUIPMENT

A. Control Wire: Insulated single-strand copper, minimum AWG No. 14, 600 V UL-approved as Type UF. Copper conductor meet or exceed ASTM B-3. Red, white, orange, and black colors must be available. Sufficient quantities must be supplied to meet splice and extra-wire requirements listed under control wire installation. Control wire size must meet or exceed Rainbird and Toro irrigation control wire specifications including length of run/size ratio. Provide tracer tape attached to control wire at 10'-0" o.c.

B. Splice: Make watertight electrical wire splices with either 3-M, Scott's Lock Seal tack 3576-78 or Pen-Tite PVC socket and sealing plug or Rainbird PT-100 series.

C. Electrical Tape: Black plastic, 3/4" wide, minimum of 0.007" thick, and all-weather type.

D. Duct Tape: All-weather cloth tape.

E. Trace Wire: Bare #10 solid copper.

F. Flow Sensor Cable: PE-89, 6 pair wire, and shielded as listed on drawings.

2.11 DRAIN ROCK

A. Unfractured rock; 100" passing 1-1/2" square sieve and 0% passing 3/4" square sieve.

2.12 RAIN SHUT OFF DEVICE

A. As specified on the Drawings.

2.13 WIRELESS REMOTE CONTROL

A. As listed on Drawings.

2.14 MISCELLANEOUS EQUIPMENT

A. Provide all equipment called for by the drawings, and incidental to the installation.

PART 3 - EXECUTION

3.1 INSPECTION

A. Discrepancies: Upon initiation of work or at earliest time discovered, report to the Architect any deviations between the irrigation drawings and the site. Failure to do so prior to the installing of equipment, and resulting in replacing, and/or relocating, or additional equipment, shall be done at Contractor's expense.

B. Installation of piping prior to establishment of correct subgrade elevations is strongly discouraged. Contractor must attain specified bury depths.

C. Available Pressure Verification: Prior to the start of any work, verify the assumed static pressure at point of connection. Notify Architect in writing of pressure available for approval to proceed.

D. Plant Materials: Locate irrigation lines to avoid proposed plant material locations and any existing trees. Minor field adjustments may be made by the Architect to shrubs to avoid equipment. If conflict occurs with tree pit, relocate irrigation line at no additional cost.

3.2 PERFORMANCE

A. Stake the sprinkler irrigation system head locations following the schematic design shown on the plans for approval before the construction begins. Alterations and changes in the layout may be expected in order to conform to the ground conditions and to obtain full and adequate coverage of water. It is understood that corrective measures may become necessary but no changes or alteration in the system as planned shall be made without the prior authorization of the Landscape Architect.

B. Where connections to existing stub-outs are required make necessary adjustments in layout to connect should stubs not be located exactly as shown. Adjust layout as necessary to install around existing work. Where piping is shown to be under paved areas, but running parallel and adjacent to planted area, intention is to install piping in planted areas. Do not install directly over another line in same trench.

C. Water service connections shall conform to the requirements set forth by the supplying agency, and all codes and ordinance.

D. Trenching: Trenches shall be excavated for all pipe to provide a minimum depth of cover below finish grade as follows:

1. Mainlines - 18”
2. Laterals - 12”

E. Excavate no wider at any point than is necessary to lay the pipe or installation equipment. Excavate with vertical sides and provide bracing and shoring as required.

F. Excavate to depth required in any material encountered with no extra compensation. Materials unsuitable for bedding of pipe to be removed to depth 4" below trench as directed by Landscape Architect. Suitable bedding material shall be import sand as specified.

G. Exercise care when excavating trenches near existing trees. Where roots are 2" and greater in diameter, except in the direct path of the pipe, hand-excavate and tunnel. When large roots are exposed, wrap with heavy burlap for protection and to prevent excessive drying. Trenches dug by machines shall have the sides hand-trimmed, making a clean cut of the roots. All roots 1/2" and greater in diameter that are cut and trimmed shall be treated with an approved tree wound dressing. Trenches having exposed tree roots shall be backfilled within 24 hours unless adequately protected by moist burlap or canvas.

H. The top 6" of topsoil, when such exists, shall be kept separate from subsoil and shall be replaced as the top layer when backfill is made.

I. Piping:

1. Drain Valves: Installed at Point of Connection only. Each drain to have 3 cu. ft. drain rock sump. Install valves as per detail. Locate sumps outside of paved areas, use off-sets if necessary. System will be winterized by compressed-air blowout throughout quick coupler.
2. Pipe Placement: Plastic pipe shall be installed in a manner so as to provide for expansion and contraction as recommended by the manufacturer. Provide tracer wire attached to pipe 5’ o.c./mainlines only.
3. Sleeves: Where sleeves are required, extend sleeve 12” beyond edge of pavement.

J. Jointing:

1. General: All threaded joints (PVC or galv.) shall be sealed with Teflon tape or Rectorseal "Heavy Duty" #100 virgin Teflon thread sealing paste only (no substitutes).
2. Care shall be taken to not over-tighten fittings.
3. Keep interior of pipes clean and free from dirt, debris, excess solvent, pipe cuttings or burrs, and ream to full diameter. When pipe laying is not in progress, close ends of pipe.

K. PVC Pipe: Use two-step solvent weld process only, apply as per manufacturer's recommendations.

L. No water shall be permitted in pipe until a period of at least 10 hours has elapsed for solvent weld-setting and curing.

M. The joints shall be allowed to cure at least 24 hours before pressure is applied to the system.

N. Only factory-threaded schedule 80 PVC pipe may be connected to a threaded fitting without an adapter.

O. No male PVC adapters permitted. Use only female PVC adapters with galvanized steel pipe nipples (3" min. length). Street ells permitted only for triple swing joints, and only "Marlex" Schedule 40 high-density polyethylene (no substitutes).

P. Installation:

1. General: See details for general installation requirements. Provide sufficient clearance for materials requiring maintenance. Install all materials as per manufacturer's recommendations.
2. Sprinkler Head/Quick Coupler: Risers for all sprinkler heads and quick-coupler valves shall be standard triple-swing joining type as detailed; made with Schedule 80 PVC threaded fittings.
3. Minimum riser size shall be the iron pipe size of the sprinkler head or quick coupler.
4. All sprinkler heads and quick coupling valves shall be set perpendicular and flush to finished grades. Heads in lawn areas must be slightly depressed to avoid mower damage. Provide sod at field rotor heads. Adjust field grades at heads as needed to avoid high spots at sod transition.
5. Spray pattern shall not overthrow onto structures, glass, parking lots, walkways, or public right-of-ways.
6. Locate heads to avoid possible damage by cars.
7. Heads must be within 6” of edge of paving or curbs.
8. Heads must be 12” from face of building.
9. After Fine grading/mulching adjust all head heights as necessary.

Q. Valves: Enclose all valves (including automatic control valves and PRV's) in valve boxes except manual or drain valves which are to be enclosed in protective sleeves with locking caps. Valve box extension may be required. Install as per detail and locate precisely by dimensions to two fixes objects on as-built drawings.

R. Valve bonnet packings and bolts shall be checked and tightened before backfilling.

S. Control Wiring Installation: Wiring between automatic controller and automatic control valves shall conform with national Electrical Code, latest edition, and shall have a common neutral, white; and separate control conductor for each valve.

T. Splices will be permitted only at junction boxes, valve boxes, or at control equipment. A minimum of 2 ft. or excess conductor shall be left at all splices, terminal, and control valves to facilitate inspection and future splicing. Encapsulate all splices with approved sealants. Run a bare copper trace wire from the controller along all mainlines to the furthest zones. Tape wire to bottom of main at 5' maximum intervals. Provide 24” loop of excess control wire at each valve box. Provide 4 spare wires looped through entire system – labeled at each J-box and valve box.

U. Clean-Up: Keep the premises free from rubbish and debris at all times and arrange material so as not to interfere with other operations on the job site. Remove all unused material, rubbish, and debris from the site.

3.3 INSPECTIONS AND TESTING

A. General: To be valid, the pressure tests must be performed under the direction of the Landscape Architect. The Contractor must give 48 hours' notice to the Landscape Architect when inspection is required. The location, inspection and testing provisions for these specifications will be strictly adhered to.

B. If, for any reason, any part of the sprinkler system is backfilled before location, testing, or inspection, it must be completely uncovered and exposed until approved for backfilling by Architect.

C. The Architect reserves the right to direct the removal and replacement of any items which, in his opinion, do not present an orderly, reasonably neat, or workmanlike appearance, provided such items can be properly installed in such orderly way by the usual methods in such work. Such removal and replacement shall be done, when directed in writing, at the Contractor's expense without additional cost to the District.

D. Preliminary Inspection/Pressure Testing: Prior to request for preliminary inspection of arrival of Architect, accomplish the following:

1. All pipe and valves (including drain valves and quick couplers) and all other equipment except sprinkler heads in place.
2. Cap all risers except first riser from valve on each lateral (one uncapped riser per lateral), typical.
3. Purge all air from main lines.

E. Test of Mains and Valves: With all valves in place and closed, test at 150 psi minimum for 30 minutes without introduction of additional service or pumping pressure. Testing shall be done with one pressure gauge installed on the line where directed by Architect. Lines which show loss of pressure exceeding 5 psi at the end of specified test periods shall be rejected. The Contractor shall correct installations rejects, and retesting will be performed as specified herein.

F. Test of Laterals: Purge all air from laterals and cap all risers. Open valves and bring system to line pressure. Lateral lines will be inspected visually. Lines which evidence visible leakage shall be rejected.

G. Backfill: After placement of tubing, connection to rigid PVC supply and exhaust headers, initial system flushing, installation of the line flushing valve testing, inspection and approval, backfilling can begin with specified backfill. Backfill when PVC pipe is not in an expanded condition due to heat or pressure. Cooling the pipe can be accomplished by operating the system a short time or by backfilling in the early part of the morning.

H. Compaction:
1. Trenches shall be thoroughly water settled. No sluicing will be permitted. Trenches above structure are to be hand tamped only.
2. Trenches or tunnels under paved areas shall be backfilled and tamped with a mechanical tamper in successive 6" lifts.

I. Backfill for all trenches, regardless of the type of pipe covered, shall be compacted to minimum 95% density under pavements, 85% under planted areas.

J. Rejected Systems: Rejected systems or portions of systems requiring repair and retesting in the manner specified.

K. Final Inspection/Operations and Coverage Check: Prior to request for final inspection or arrival of Architect accomplish the following:

L. Complete all work, including balancing, adjusting the system (pressure reducing valves, flow adjustment keys, nozzles, etc.) to provide optimum coverage without fogging. Backfill all except valve boxes.

M. Coverage Check: Operate each zone of the system for the Architect's inspection.

3.4 SYSTEMS OPERATION ORIENTATION

A. At time of and as part of the final inspection, conduct a training and orientation session for the District covering the operation, adjustment and maintenance of the irrigation system. The "as-built" plans and operations manual shall be reviewed and all features explained. The Contractor shall notify the Architect in writing two weeks prior to the training and orientation session. The date and time of the session shall be subject to approval of the Architect.

3.5 EXTENDED MAINTENANCE

A. Under this contract, provide extended maintenance for one year from the point of substantial completion for each phase of work for all landscape areas. Refer to Section 329000. Included in this scope is operation, adjustment, balancing, monitoring, repair and replacement, winterization and spring start up, and other operations associated with the utilization of the irrigation system.

END OF SECTION 328000

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to work of this Section.

1.2 DESCRIPTION OF WORK

A. Work includes all materials, equipment and labor necessary for: decompaction, placing topsoil, finish grading, planting of trees, shrubs and ground covers, seeding, protection, extended maintenance, guarantee and replacement; and related items necessary to complete the work indicated on the drawings and/or specified.

Note: Prior to bidding the work of this Section, Contractors shall visit the site to generally familiarize themselves with existing conditions, soils, slope, access, and other apparent site conditions.

1.3 QUALITY ASSURANCE

A. Plant Material: All plant material quality, size and condition as determined by the current edition of American Association of Nurserymen Standard. Plant names shall conform to latest edition of "Standardized Plant Names" as adopted by American Joint Committee of Horticulture Nomenclature.

B. Fertilizer: Conform to Washington State Department of Agriculture Laws and Federal Specification O-F-241D pertaining to commercial fertilizers.

C. Soil: Conform to USDA soil textural class.

D. Seed: Conform to Washington State Department of Agriculture Rules for Seed Certification.

E. Compost: Compost to be certified in accordance with the U.S. Compost Council Seat of Testing Assurance (STA) program.

1.4 SUBMITTALS

A. Plant Materials: All plant material shall be ordered immediately following the award of contract. Contractor responsible for assuring that plants of specified sizes and quantities will, in fact, be as specified at the time of planting. Provide District with copies of purchase orders for all plants delivered to the site.

1. Within 30 days after award of contract, submit documentation that all plant material and seed has been ordered.

B. Import Topsoil: Submit one-half gallon sample of import topsoil mix for approval by Landscape Architect.

C. Compost: Submit source and one-half gallon sample of compost amendment for approval by Landscape Architect.

D. Wood Chip Mulch: Submit source and one-half gallon sample of mulch for approval by Landscape Architect.

E. Coarse Sand: Submit source and one-half gallon sample for approval by Landscape Architect.

1.5 SOIL TEST REQUIREMENTS

A. Soil testing to be performed on all topsoil mixes and their components not more than 90 days prior to installation. Provide a second test and soil sample at delivery of material to the site.

B. Topsoil Analysis: Furnish complete soil analysis on the final mix of full topsoil components and provide a written report by a qualified soil-testing laboratory stating the following:

1. pH
2. C:N Ratio.
3. Percentage of organic matter by weight LOI (loss on ignition), ASTM D 2974 Method D.
4. Gradation of sand, silt and clay content per USDA soil texture classification.
5. Cation exchange capacity.
6. Maximum exchangeable sodium.
7. Maximum electrical conductivity.
8. Sodium absorption ratio.
9. Deleterious material.
10. Mineral and plan-nutrient content of the soil.

C. Soil Nutrient Analysis:

1. Soil Nutrient Analysis to include levels of the following nutrients: Nitrogen, Phosphorus, Potassium, Calcium, Magnesium, Sulfur, Boron, Chlorine, Cobalt, Copper, Iron, Manganese, Molybdenum, and Zinc.
2. Based upon test results, provide recommendations for soil treatments and soil amendments. State recommendations in weight per 100 sq. ft., or volume per cu. yd. for nitrogen, phosphorus, and potash nutrients, and soil amendments to be added to produce satisfactory soil suitable for healthy, viable plants.
3. Report presence of problem salts, minerals, or heavy metals, including aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, lithium, and vanadium. If such problem materials are present, provide additional recommendations for corrective actions.
4. Analysis of heavy metals and other toxics per WAC 173-340.
5. State suitability of tested soil for plant growth.

D. Infiltration test/ Hydraulic Conductivity: Provide test results for bio-retention soil mix per ASTM D2434 at 85% compaction per ASTM D 1557.

E. Compost Analysis: tests to be performed not more than 3 months prior to installation. Provide test results for the following:

1. Organic content by percent of dry weight LOI (loss on ignition), ASTM D 2974 Method D.
2. Moisture content.
3. C:N Ratio.

4. pH.
5. Soluble Salt Concentration.
6. Ammonium nitrogen.
7. Nitrate Nitrogen.
8. Particle size Sieve analysis per USDA soil texture classification.
9. Stability – Carbon Dioxide Evolution Rate.
10. Maturity.
11. Seed Emergence and Seedling Vigor.
12. Bulk density.
13. Nutrient content of N-P-K.
14. Provide verification of manufactured compost satisfying definition of “composted materials” per WAC 173-350 Section 220 and is not derived from Type 4 feedstocks.
15. Provide verification of manufactured compost meeting the US Composting Council’s “Seal of Testing Assurance” (STA) program.
16. Analysis of heavy metals and other toxics per WAC 173-340 MTCA.
17. Provide documentation that all stock piled compost remains covered during processing.
18. Provide documentation that compost has been aged minimum of 6 months.

F. Soil-Testing Laboratory Qualifications: An independent or university laboratory, with the experience and capability to conduct the testing indicated. The testing laboratory shall be an approved laboratory through the North American Proficiency Testing Performance Assessment Program (NAPT-PAP) and shall be affiliated with one of the following:

1. National Society of Consulting Soil Scientists (NSCSS).
2. Soil Science Society of America (SSSA).

1.6 PROTECTION OF EXISTING CONDITIONS

A. Protect work, adjacent property, public, and be responsible for any damage or injury arising from this contract due to actions or neglect.

1.7 SCHEDULING

A. Upon commencing work, the General Contractor shall examine the site and protect all trees, shrubs and other areas designated to remain in a manner substantial enough to resist the forces of construction equipment that will be on site.

B. Confine work to areas designated. Do not disturb existing vegetation outside of project limit lines. Protect all trees within project limits not designated to be removed. Repair or replace vegetation damaged as a result of Contractor's operation to satisfaction of District at Contractor's expense.

1. Contractor shall install temporary fencing at locations shown on plans for trees to remain prior to grading.

C Contractor shall be cognizant of all utility lines and underground obstructions and shall familiarize themselves with all utility, irrigation, mechanical, and electrical plans so that digging/drilling operations do not damage lines. Repair or replacement by original installer shall be made at Contractor's expense for all existing buildings, equipment, underground utilities, irrigation equipment, paving, surfacing, stairs, and/or forms damaged because of Contractor's operations in a manner satisfactory to the District before final payment is made.

D. Protect plants, roots, balls and tips at all times from injury in handling, from sun or drying winds from beginning of digging operations, during transportation and on site until final planting.

E. Provide all necessary safeguards, as approved and/or required by the Landscape Architect, for the protection of all planted areas until provisional inspection/acceptance is accomplished, or for such time as it requires to assure vigorous establishment of the plant material.

1.8 QUALITY CONTROL AND REVIEW

A. Notification: The Contractor shall give 48 hours' notice to the Landscape Architect when an inspection is desired.

B. Inspections:

1. Field Subgrades: Subgrade shall be reviewed by Landscape Architect and approved by the District's representative prior to topsoil placement and finish grading.
2. Rough Grades: Landscape Architect will review subgrades prior to placement of topsoil.
3. Rototilling: Landscape Architect will review Contractor's tilling and soil incorporation methods prior to establishment of finish grades.
4. Finish Grades: Landscape Architect will review finish grade prior to any planting or seeding.
5. Plant Material: Landscape Architect will review all plant material at the site prior to installation. Remove unsatisfactory material from site immediately.
6. Plant Locations: Landscape Architect will review and adjust plant locations prior to installation.

1.9 PROVISIONAL REVIEW (Punch List)

A. Upon substantial completion, the Contractor shall request a provisional inspection. No partial approvals will be given.

1.10 FINAL REVIEW/ACCEPTANCE

A. The Contractor shall request a final inspection upon satisfactory completion of all punch list items and any other work required under this contract. Substantial completion of each phase of work shall establish the guarantee and maintenance period of that phase of work. Acceptance shall be defined as the completion and approval of all landscape punch list items.

1.11 GUARANTEE REPLACEMENT

A. Plant Material: Guarantee in a healthy, thriving condition all trees and shrubs for one year from date of final acceptance; all ground cover until active, vigorous growth is evident. During the guarantee period, all dead diseased, dying, broken or disappeared plant materials from any cause except those noted below shall be replaced immediately by the Contractor at no additional expense to the District. Use specified plants and plant as specified; guarantee until active, healthy growth is evident.

The Landscape Architect shall determine if a tree or shrub is dead based on the following;

A tree shall be considered dying or dead when the main leader has died back, or a minimum of 25 percent of the crown has died or been damaged. A shrub or groundcover shall be considered dying or dead when a minimum of 25 percent of the plant has died or been damaged.

B. Seeded Areas: Guarantee a relatively uniform, acceptable stand of grass with no bare spots whatsoever in all lawn areas at time of provisional review (punch list). Reseed with the seed and in the manner originally specified any seeded area which fails to vigorously establish a uniform stand for any reason whatsoever. Fill to finish grade with approved topsoil and seed as specified all seeded areas which evidence settlement or erosion. Repeat all such reseeding until final acceptance at Contractor's expense.

C. Contractor's Responsibility: During guarantee period, Contractor shall not be responsible for replacing plants destroyed or damaged by vandalism or accidents caused by vehicles other than the Contractor's, or Acts of God, or severe cold as substantiated by 25-year low temperature records (exceeding 25-year low), provided that Contractor has exercised due care to protect work. Should replacement fall due during non-planting season, contractor may request District's permission to defer planting until proper season. If permission is granted, immediately remove and dispose of dead plants, including all roots. Holes shall be backfilled properly with planting mix and finish graded until proper planting season occur. Plants used for replacement shall be of same kind and size originally planted and they shall be planted as originally specified.

D. Watering: In non-irrigated areas, provide temporary irrigation and water as required to germinate seed and create a healthy vigorous stand of turf. Water all areas to final acceptance. Contractor’s temporary irrigation measures must be enough to water all areas once daily.

PART 2 - PRODUCTS

2.1 SOIL

A. Import Constructed Topsoil consisting of a well-blended mix of 40% sandy loam topsoil, 40% sand, and 20% compost, free of weeds, sticks, clay clumps or any other material over 2” in diameter. Maximum 20% passing the #200 sleeve. Test and amend per soil test requirements.

B. Certified Test Lab Reports: The certified test lab reports required in this section shall be submitted by the Contractor as early as possible to avoid potential delays in the contract due to sample rejections.

C. Compost shall meet the following physical and chemical criteria:

1. The material shall be visually free of manufactured inerts such as glass, metal and plastic and shall be less than 1.0-percent by weight as determined by U.S. Composting Council TMECC 03.08-A “Classification of Inerts by Sieve Size,” and visually free of identifiable grass or leaf fragments.
2. The material shall be visually free of manufactured inerts such as glass, metal and plastic.
3. No fresh sawdust or other fresh wood by-products shall be added to extend the volume after the composting process.
4. Compost shall be prepared by the controlled decomposition of organic materials. Acceptable feedstocks include, but are not limited to, yard debris, wood waste, land-clearing debris, brush, branches, manure, food residuals, and forest by-products. Type 4 feedstocks are not acceptable.

5. The product shall have a uniform, dark, soil-like appearance and an earthy loam-like odor. No ammonia or putrid smells shall be present.
6. Compost for the approved rates listed above must meet the definition for “composted materials” in WAC Chapter 173-350 Section 220 or manufactured topsoil.
7. Compost must meet the standards of the US Composting Council’s “Seal of Testing Assurance” (STA) program.
8. No Class B biosolids shall be included.
9. Compost shall comply with all applicable public health standards and be obtained from a compost facility that holds a solid-waste handling permit from the health department with jurisdiction.
10. Compost must include a minimum of 65-percent by volume “Type 1 Feedstocks” in WAC 173-350. The manufacturer shall provide a list of feedstock sources by percentage in the final compost product.

    a. Yard waste shall be from a permitted composting facility such as Cedar Grove or approved equal.
    b. Material derived from aerobic decomposition of recycled plant waste fully composted for a minimum of 6 months between 131 F and 165 F; materials shall have a moisture content such that no visible free water or dust is produced when added after the composting process has begun.

Product Parameters	Specification Range
Sieve Analysis	100% passing through a 3” sieve, 70-100% passing through a 3/4” sieve, 40-60% passing through a 1/4” sieve 6” Max. Particle size
Organic Matter	40-60% of dry weight (LOI)
pH Tested in accordance with U.S. Composting Council TMECC 04.11-A, “1:5 Slurry pH.”	5.5-7.5pH Units
C:N Ratio Tested in accordance with U.S. Composting Council TMECC 04.01, “Total Carbon” and 04.02-D “Total Kjeldahl Nitrogen”	12:1-35:1 Carbon to nitrogen ratio
Soluble Salt Concentration Tested in accordance with U.S. Composting TMECC 04.10 “Electrical Conductivity.”	< 4 dS/m (mmhos/cm)
Moisture Content	40-60% wet weight basis
Ammonium nitrogen	<500 ppm

Nitrate nitrogen	Report amount ppm
Stability Tested in accordance with U.S. Composting Council TMECC 05.08-B “Carbon Dioxide Evolution Rate.”	< 8 Mg CO_2-C per g OM per day
Maturity Tested in accordance with U.S. composting Council TMECC 05.05-A, “Germination and Root Elongation.” (Seedling Vigor and Emergence)	Minimum 80% relative to positive control
Select Pathogen Salmonella Per WAC 173-350-220 Table B	< 3 MPN per 4 grams of total solids

D. Sand: Clean, washed, natural or manufactured sand, free of toxic materials.

1. Coarse sand is comprised of the following:

Item	Size in mm	Percentage
Fine Gravel	2.0-3.4 mm	0-10%
Very Coarse Sand	1.0-2.0 mm	
Coarse Sand	0.5-1.0 mm	50-60%
Medium Sand	0.25-0.50 mm	
Fine Sand	0.15-0.25 mm	10-20%
Very Fine Sand	0.05-0.15 mm	0-5%
Silt	0.002-0.05 mm	0-5%
Clay	Less than 0.002 mm	0-3%
Total Fines	Very fine sand + silt + clay	0-10%

2.2 PLANTS

A. Quantities, species and varieties, size and condition as shown on planting plan and plant list. Plants to be Washington Grade No. 1 and fresh, well foliaged, in prime condition when in leaf, exhibiting normal habit of growth, having all buds intact and free of disease, injury, insects, insect eggs, larva, indication of strawberry root weevil, all seeds and weed roots.

B. All plants shall be from stock which has been acclimated to conditions prevailing at the project and which has been consistently cultivated and grown in these conditions. No cold storage plants; all grafted trees to be grafted at ground level.

C. Balled and burlapped (B&B) stock to have a natural ball sufficient to insure survival and healthy growth; bare root (BR) materials to have sufficient root system to insure survival and healthy growth.

D. Substitutions are strongly discouraged. No substitutions shall be made without the written approval of the Landscape Architect. Requests for substitutions must be made at the time that documentation of ordered plant material is provided. The substitution request must be

accompanied by written proof from at least five sources (major suppliers of the plant) that any plant is not available.

E. Plants must be installed no more than 30 days after delivery to site. Provide adequate water by temporary means to keep plants in top condition. Store plants in protected location away from hot sun and strong, drying wind.

2.3 LAWN SEED MIX

A. Minimum three Cultivars (1/3 of each) as approved. Seed at minimum rate of 8 lbs/1000 sf., or greater if recommended by supplier.

	Proportions by Weight	Percent Purity	Percent Germination
Regenerating Perennial Rye (RPR)	85%	98%	90%
Kentucky Bluegrass	15%	98%	90%

B. Hydromulch: Silva-fiber or approved at minimum rate of 2000 lbs/acre.

C. Tackifier: Use on all sloped areas steeper than 5:1 at manufacturer’s suggested rate.

2.4 FERTILIZERS AND SOIL AMENDMENTS

A. General: Approved brands conforming to applicable State fertilizer laws. Uniform in composition, dry, free-flowing, delivered to the site in original unopened containers, each bearing the manufacturer's guaranteed analysis. All fertilizers must be EPA approved. Fertilizer needs to be based on results of soil test

B. Trees, Shrubs and Ground Cover:

1. Formula 4.2.2 "Transplanter" as manufactured by Pacific Agro Co., with Hercules Nitroform and W.R. Grace's "Magamp" and trace elements. Apply at rate of:

a. Trees: 8 oz.
b. Shrubs: 4 oz.
c. Ground Cover: 2 oz.

C. Agriform Tablets: Planting tablets, 21-gram size, as manufactured by Agriform International Chemicals, Inc., 20-10-5 analysis. Apply at the rate of:

1. Trees: 4 tablets
2. Shrubs: 2 tablets
3. Ground Cover: 1 tablet

D. Seeded Lawn Areas:

1. Installation Fertilizer (Fertilizer ‘A’):

a. Total available Nitrogen: 16% by weight (of which 50% is derived from controlled release sources including Nutralene.)

b. Total available phosphorous: 16% by weight.
c. Total available potassium: 16% by weight.

E. Maintenance Fertilizer:

1. Initial Fertilizer (Fertilizer 'B'):

a. Total available Nitrogen: 21% by weight (of which 50% is derived from controlled release sources.)
b. Total available Phosphorous: 12% by weight.
c. Total available Potassium: 12% by weight.

2. Follow-up Fertilizer (Fertilizer 'C'):

a. Nitrogen: 19% by weight.
b. Phosphorous: 4% by weight.
c. Potassium: 16% by weight.

F. Dolomitic Limestone at minimum rate of 50 lbs. per 1,000 square foot. Gypsum to counteract salinity as recommended in report.

G. Other amendments as recommended in report; adjust the basic quantities of the following micronutrients as recommended in the report: iron, manganese, molybdenum, copper, zinc and boron.

H. See also Fertilizer Requirements under Section 3.8 Maintenance.

2.5 STAKES AND GUYS

A. Material as per standard detail.

2.6 WOOD CHIP MULCH: 3" depth

A. "Arborist Chips", chipped woody material approximately 1 to 3 inches in maximum dimension (not sawdust or coarse hog fuel). Mulch shall not contain appreciable quantities of weeds, garbage, plastic, metal, soil and dimensional lumber or construction/demolition debris.

2.7 SELECTIVE HERBICIDE

A. Treat all planting beds with a selective pre-emergent herbicide and remove all foreign weeds prior to acceptance.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clear and grub any areas shown beyond civil clearing limits as needed to install landscape work.

B. Clearing limits and subgrade shall be reviewed by Landscape Architect and approved by the District's representative prior to topsoil placement and finish grading.

3.2 DECOMPACTION/OVEREXCAVATION

A. Wherever landscape is proposed over compacted areas that were previously paved, buildings, construction traffic areas, Contractor staging areas or areas otherwise detrimental to plant establishment, the Contractor shall completely remove all remnants of paving, crushed rock, quarry spalls, contaminants or other non-native material as directed by the Landscape Architect. Loosen the soil in these areas to a minimum depth of 12" below subgrade using mechanical means.

3.3 SUBGRADE

A. Subgrades shall be below finish grade as indicated below to accept required depth of soil and mulch. Prior to placing topsoil, remove all rocks and sticks over 2" diameter. Take care not to damage existing tree and shrub roots.

1. The following amounts of topsoil and mulch shall be applied:

    a. Lawn / Seeded areas - 8" import topsoil.
    b. Planting beds - 8" import topsoil, 3" mulch.

B. Fine grade all planting areas as necessary to complete all planting operations. Establish finish grades in accordance with elevations shown in the drawings, ensuring that no pockets or surface irregularities create obstructions to positive drainage. Ensure positive drainage away from building. Obtain approval of finish grades prior to all seeding or planting.

3.4 TOPSOIL PLACEMENT (GENERAL)

A. Place 4" of specified import topsoil uniformly over entire planting and seeded areas, and thoroughly roto-till to a depth of 6" to incorporate subsoil with topsoil, paying special attention to thoroughly mix and loosen soil in areas compacted by construction. Contractor to request review by Landscape Architect of tilling and soil incorporation methods prior to placement of second lift of topsoil.

B. Place remaining 4" import topsoil over entire rototilled area after review by Landscape Architect.

C. Rake, float, drag, roll and perform all necessary operations to remove surface irregularities and to provide a firm, smooth surface with positive surface drainage. Remove all rocks, sticks and other debris 2" and larger in planting areas and in lawn areas. Box drag and hand rake all seeded areas.

D. Finish grade after installation of topsoil and mulch shall be 1/2" below adjacent paved surfaces unless otherwise specified or detailed.

3.5 WOOD CHIP MULCH

A. Place 3” depth of wood chip mulch in all new planting beds and around existing trees throughout areas shown on plan to remain. Avoid burying trunks of trees. Feather mulch into surrounding new and existing landscape areas.

3.6 INVASIVE REMOVAL

A. Remove all invasive plant species throughout work area of site. Species include but are not limited to English Ivy, Himalayan Blackberry, English Holly, and Cherry Laurel.

B. Remove ivy from ground and tree trunks. Avoid damaging trees or existing native understory to remain.

C. Remove or kill entire plant and root structure of all invasive trees and shrubs.

D. Continue removal throughout extended maintenance period.

3.7 PERFORMANCE

A. Planting and Plant Relocation Time: Plant trees, shrubs, groundcover and lawn during periods which are normal for such work, as determined by season, weather conditions, and accepted practice. At the option and on the full responsibility of the subcontractor, planting operations may be conducted under unseasonable conditions without additional compensation.

B. Plant Locations: After placement of topsoil, stake tree locations and position shrubs above ground as per drawings for approval of Landscape Architect. Make field adjustments to avoid obstructions to planting. Landscape Architect reserves the right to field adjust plant locations prior to planting.

C. Planting Trees: Excavate tree pits 6" deeper and twice the diameter of the root ball. Excavated soil shall be removed from the site. Thoroughly scarify bottom of pits by shovel cutting to a depth of 12". Sides of pits shall also be shovel cut to help root penetration. Establish a firm mound to position the top of the root ball flush with finish grade of mulch layer.

D. Place tree in upright position in center of pit, release root covering or spread roots. If wire cages are present, remove completely and dispose from site. Roots of trees shall be so placed as to have a natural spread and distribution and planting mix shall be carefully, thoroughly packed and puddled around them. Take care not to injure root system while backfilling and compacting. After water settles, fill again with planting mix and water compact to a grade of not more than 1/2" higher than the original ball. In seeded areas, finish grade smooth with surrounding area. Provide 3' diameter, 3” depth mulched circle around all trees in seeded areas.

1. Fertilize trees at the soils test recommended rate applied uniformly around circumference of root spread under a cover of 2" of planting mix. Apply Agriform tablets and soil polymers per manufacturer’s recommendations. Stake and guy trees immediately after planting as detailed. All supports and trees shall stand vertical.

E. Planting Shrubs and Ground Covers: After topsoil placement and approval of finish grade, excavate planting pockets at locations shown on drawings and as directed to a diameter of twice

the root spread and to a depth that will ensure a 3-inch cushion of compacted planting mix below the root ball. Dispose of excavated soil on site as directed.

1. Set plants upright in center of hole flush with finish grade, release root covering or spread roots. The roots of the plant shall be placed as to have a natural spread and distribution. Backfill with planting mix and provide slight depression as watering saucer. Care shall be taken not to injure the root system while backfilling and compacting the planting mix.
2. Fertilize at the specified rate applied uniformly around the circumference of the roof spread under a cover of 2" of planting mix. Apply Agriform tablets and soil polymers per manufacturer's recommendations. Plant ground cover plants at spacing indicated in straight, evenly spaced rows.

F. Pit plant trees and shrubs in areas outside of clearing limits as shown on plans. Avoid disturbance to existing native vegetation to remain. Mulch all exposed soil to minimum 3" depth.

G. Seed Bed Preparations: Apply Installation Fertilizer 'A' and dolomite limestone at the soils test recommended rate. Add other fertilizers as recommended in soils report. Rake to incorporate. Finish surfaces by raking smooth and even; lightly compact with roller. Level out surface undulations and irregularities to tolerances specified in Section 02200 and compact again as necessary.

H. Lawn Seeding: After approval of finish grade, seed at the rate specified. Seed all areas using hydro-seeder and hydro-mulch at rate specified under Hydro-mulch Section.

I. Timing: Seed only from March 15 to October 15, or as approved by District's representative. All seeding must be complete prior to project substantial completion date.

J. Protection: Protect against harm from wind, storm water and trespassing. Treat and reseed damaged portions as required. Reseed as many times as necessary to achieve Guaranteed Replacement. Post signage indicating new seeding as necessary to prevent trespassing. Provide temporary orange construction fencing around seeded areas, until grass has become fully established as determined by the Landscape Architect.

K. Initial Maintenance Fertilization (Fertilization 'B'): Apply fertilizer at the rate of 2-1/2 lbs. per 1,000 square feet after the first mowing. Apply once each week through the third mowing, minimum three applications.

L. Follow-up Maintenance Fertilization (Fertilizer 'C'): Apply fertilizer at the rate of 8 lbs. per 1,000 square feet on week after the last application of Fertilizer 'B'.

M. Reseeding: In areas which were seeded after October 15th, reseed and re-fertilize all areas where coverage is weak or sparse, as directed in the spring of the following year, and repair any settlement and/or erosion channels.

N. Ongoing Maintenance: Contractor shall continue to maintain turf areas and weed the entire site until 60 days from substantial completion. See additional requirements under Section 3.8 Maintenance.

O. Mulching: Immediately after completion of all planting, mulch all new planted areas to a minimum compacted depth of 3". Refer to site details for proper relationship of finished grade to adjacent paved areas, 1/2" below curbs/walks unless indicated otherwise. Mulch around existing trees and any areas of exposed soil outside of clearing limits.

P. Pruning, Repair and Weeding: Upon completion of the work under this contract, all existing and new trees and shrubs shall be pruned as directed by Landscape Architect to control size, remove dead or damaged branching or to correct overall form.

1. Pruning shall be done in such a manner as not to change the natural habit or shape of the plant. All cuts shall be made flush, leaving no stubs. On all cuts over 3/4" in diameter and bruises or scars on the bark, the injured cambium shall be traced back to living tissue and removed. Wounds shall be smoothed and shaped so as not to retain water, and the treated area shall be coated with approved tree wound compound

3.8 MAINTENANCE

A. It shall be the Contractor's responsibility to continuously and vigorously maintain all the landscaped areas of this contract from time of installation until 60 days after substantial completion of last phase of the entire project. Contractor to continue to maintain completed phases of work by continually weeding and watering on a weekly basis. Apply fertilizer at start of spring, summer and fall seasons throughout project duration. Apply additional mulch by topping off where necessary to ensure all areas have 3” bark mulch at end of maintenance period. Sweep pavement clean and remove dead plants as directed by the Landscape Architect, who shall record plants removed. All plants shall be watered by thorough sprinkling as needed to keep the ground moist, the plants healthy, and to prevent wilting, including watering in areas not fully covered by an automatic irrigation system. Care shall be exercised to prevent soil erosion.

B. Provide temporary irrigation as needed to all areas not covered by permanent irrigation system. Temporary irrigation provisions shall be enough to water all areas at least once daily. Watering methods shall be designed to minimize overspray on to paved surfaces or established landscape areas. Design of temporary irrigation shall be subject to approval by Landscape Architect.

C. Seeded Areas: Maintain by watering, weekly mowing (remove all clippings) continuous weeding, reseeding, fertilizing, herbicide treatment, rolling and top dressing, and other necessary operations to establish and maintain an even, dark green, deep rooted, thick and vigorous stand of grass. Temporarily water any areas that are not irrigated, until establishment.

1. Replace any seeded areas which fail to show vigorous growth. Fill and seed all areas which settle, as specified. At the end of the maintenance period and prior to acceptance, the seeded areas shall be a flourishing, dense, vigorous, uniform, deeply rooted thick stand of specified grass with no bare spots and no weeds whatsoever.
2. There shall be no foot or vehicle traffic on the seeded area whatsoever. Install a temporary 6’ height chain link fence around all lawn areas until fully established. Maintain barriers around seeded areas until established, then remove from site. Ensure safety to public throughout duration of use.
3. Trees: Maintain in a vigorous, thriving condition by watering, pruning, cultivating, fertilizing, spraying, and other necessary operations. Spraying shall be done only as required and as approved by the Landscape Architect. Plants will not be accepted until active growth is evident. All tree supports, guys, tree wrap, etc., shall be kept intact and adjusted as required and effect in maintaining firm support throughout the guarantee period.

4. Clean-up: A general clean-up shall be made immediately after and as part of all work done in the area. The clean-up shall include the entire area under this contract. Adjacent areas shall be cleaned to the extent that the work done under the contract may scatter litter. Such clean-up shall include pick-up and removal from the contract area of all clippings,

trimmings, leaves, and all other litter and debris originating from any source whatsoever. Remove flag labels from all plant material.

3.9 EXTENDED MAINTENANCE

A. Under this base bid contract, provide extended maintenance for **one year** from the point of Substantial Completion for all areas within this project's scope of work. Utilize all operations contained in this specification including daily watering, weekly mowing and continuous weeding. Prior to substantial completion, provide a detailed maintenance schedule for District review and approval, see Section 3.9C for typical maintenance tasks. At no time are the lawns to be yellow, lacking in vigor, or not thriving. At no time are trees and shrubs to be lacking in vigor and not thriving. Provide a high level of maintenance as required to keep lawns, trees and shrub beds in top condition during the duration of the maintenance period. For any portions of the landscape that are not in top condition at the point of acceptance, provide additional maintenance at no additional cost until such time as they are free of weeds or bare spots and in top quality condition. Provide a maintenance log during the duration of the extended maintenance that details exact operations performed, including dates, name of person responsible, and amount of time spent on site. Provide copies to the School District monthly, with progress payments. The playfields shall be maintained by the School District and is not included in the Contractor's area of required maintenance work.

B. Schedule all maintenance work with District to avoid conflicts with other site and school related activities.

C. Typical Maintenance Tasks:

1. These maintenance guidelines represent the typical minimum maintenance tasks. It is the Contractor's responsibility to maintain all new landscape and irrigation to the extent needed to keep all areas thriving and in top condition. Additional maintenance activities may be required beyond those listed below. The Contractor is to submit monthly logs of all activities for the District's review.
2. Irrigation:

    a. Tree/shrubs: 1/2 – 1 1/4" of water per week.
    b. Lawn: 1-1 1/2" of water per week.
    c. Check soil moisture across site monthly.

3. Fertilization:

    a. Trees and shrubs: Twice per year (usually late fall and early spring).
    b. Lawns: Three times per year (late May/early June, late August, and mid-October).

4. Weed Control:

    a. Shrub beds: Weed by hand once every 2 weeks, or more often until groundcover fills in.
    b. Lawns: As needed, coordinate any herbicide applications with District prior to application.

5. Pest Control: Scout the site monthly for evidence of pests or disease. Any treatments should be considered an alternate (only needed as necessary).

6. Pruning Trees/Shrubs: Minimal pruning required. Only prune trees and shrubs as required for safety reasons, to cut out dead or damaged material, or top pruning for safety/sight lines. Trim edges of groundcover once per month. Cut ornamental grasses to 4” height in late winter.
7. Mulch: Add fresh mulch to landscape beds and adjust mulch level at same time, once per year.
8. Edging: Mechanically edge all lawn borders once per month.
9. Mowing: Mow as necessary to maintain a lawn height of 2” in spring and fall, 3” tall in summer; or 26 times, whichever is more.
10. Irrigation System: Spring start-up in late March/early April.

    a. Activate and test system; check for coverage, malfunctions, leaks, overspray, etc.
    b. Clean all filters at point of connection and at each control valve.
    c. Check backflow preventer.
    d. Clean and thoroughly test operation of controller schedule and programming.
    e. Inspect all valve boxes and repair/set to plumb as necessary.
    f. Set all heads to plumb.
    g. Check quick-coupler valves.

D. Winterization yearly, generally late October. Miscellaneous repairs as necessary. Review controller schedule every other week, or at least once per month, adjust as needed.

END OF SECTION 329000

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. Work of this Section includes but is not limited to the following:

1. Site water distribution.
2. Piping and associated infrastructure for fire protection service outside the building.
3. Piping and associated infrastructure for potable water service outside the building.

B. Related Sections include the following:

1. Section 312000, “Earthwork,” for earthwork, trenching, bedding, and backfilling.

1.3 REFERENCE STANDARDS

A. WSDOT: Standard Specifications for Road, Bridge, and Municipal Construction, latest edition.

B. WSDOT: Standard Plans for Municipal Construction, latest edition.

C. Conform to OSHA Uniform Plumbing Code and WISHA requirements for trench safety.

D. Northshore Utility District – Water and Sewer Specifications, latest edition.

1.4 SUBMITTALS

A. Submit under provisions of Section 013300, “Submittal Procedures.”

B. Submittals that have been submitted and approved shall be available onsite for reference by the Owner and Engineer.

C. Certification:
1. Provide a letter, signed by the supplier and an officer of the Contractor’s company upon their review, certifying that the following products to be incorporated into the work meet the requirements specified.
2. All product submittals shall be submitted to the Engineer and the Northshore Utility District (NUD) for review and approval. Contractor shall deliver submittals to NUD. Water system construction shall not commence until all submittals have been approved by the Engineer and NUD.
3. Products:
   a. Pipe and fittings
   b. Restrained joint pipe and fittings
   c. Valves and valve boxes
   d. Locating wire
   e. Post indicator valve with tamper switch
   f. Fire department connection
   g. Fire hydrant assembly

h. Fire hydrant guard posts
i. Reduced pressure backflow assembly and Hotbox enclosure
j. Double detector check valve assembly and concrete vault
k. Meter boxes
l. Blow-offs and air & vacuum relief valves
m. Stainless steel tapping sleeve
n. Service materials and saddles
o. Steel casing
p. Pipe gravel bedding material
q. Trench backfill material

D. Record drawings according to Section 017700, “Closeout Procedures” and Section 017839, “Project Record Documents.”

1. Record information shall be provided by a Professional Land Surveyor that is licensed in the State of Washington.
2. Minimum record information shall include utility field changes during construction and indicating as-constructed conditions and elevations to meet Northshore Utility District standards.

E. Test Reports: As specified in Part 3 of these specifications.

F. Purging and Disinfecting Reports: As specified in Part 3 of these specifications.

1.5 QUALITY ASSURANCE

A. Comply with Northshore Utility District’s requirements, Standards, and Specifications.

B. Provide listing/approval stamp, label, or other marking on piping and specialties made to specified standards.

C. Conform to applicable code for materials and installation of the Work of this Section. Codes include, but are not limited to, the Uniform Plumbing Code (UPC), International Fire Code (IFC), and NFPA.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Preparation for Transport: Prepare valves according to the following:

1. Ensure that valves are dry and internally protected against rust and corrosion.
2. Protect valves against damage to threaded ends and flange faces.
3. Set valves in best position for handling. Set valves closed to prevent rattling.

B. During Storage: Use precautions for valves according to the following:

1. Do not remove end protectors, unless necessary for inspection, then reinstall for storage.
2. Protect from weather. Store indoors and maintain temperature higher than ambient dew-point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.

C. Handling: Use sling to handle valves whose size requires handling by crane or lift. Rig valves to avoid damage to exposed valve parts. Do not use handwheels or stems as lifting or rigging points.

D. Deliver piping with factory-applied end-caps. Maintain end-caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.

E. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.

F. Protect flanges, fittings, and specialties from moisture and dirt.

G. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

1.7 PROJECT CONDITIONS

A. Contractor shall perform connections to existing main and installation of water infrastructure under the supervision of the Northshore Utility District Inspector.

B. Contractor shall contact the Northshore Fire Department to coordinate Work and required inspections for temporary and permanent fire protection systems. See Article 1.8 “Sequencing and Scheduling”.

C. Contractor shall research public utility records and verify existing utility locations prior to construction. Contact utility-locating service for area where Project is located. Pothole and locate existing utilities as necessary to perform the Work shown on the plans and prior to connection to existing utilities.

D. Contractor shall take precautions as necessary to protect existing utilities located on the site. Protection work includes all temporary shoring to maintain soil stability relative to the existing water system.

E. Contractor shall verify that the water system is installed to comply with the Contract Documents and referenced standards.

F. Geotechnical reports of subsurface condition investigations made during theProject design are available for informational purposes only; data in these reports are not intended as representations or warranties of accuracy or continuity of conditions between field investigation points (i.e. soil borings, test pits, etc.). Owner assumes no responsibility for interpretations or conclusions drawn from this information.

1.8 SEQUENCING AND SCHEDULING

A. A preconstruction meeting shall be held with Northshore Utility District prior to any construction.

B. Phasing of construction may require the Contractor to construct temporary systems to maintain fire hydrant coverage, fire sprinkler service, or potable water service. Contractor shall expect and plan for encountering such occurrences and making adjustments to the alignments and configurations of systems to minimize disruption to the Owner’s use of premises.

C. Utility interruptions shall not be allowed during occupied hours unless permitted under the following conditions and then only after arranging to provide temporary utility services according to the following requirements:

1. Notify Architect/Owner/City/NUD not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect's/Owner's written permission.
3. Contact utility-locator service for area where work shall be performed to confirm the presence of all known existing utilities.

D. Coordinate connections to water main with Northshore Utility District.

E. Coordinate connection of fire sprinkler services and backflow protection systems with Northshore Utility District and the Northshore Fire Department.

F. Provide temporary connections to existing and new water systems as necessary to address fire protection, water service, and for other construction phasing requirements.

G. Provide fire watch in accordance with Northshore Fire Department requirements when temporary connections or down time is necessary.

H. Coordinate pipe materials, sizes, entry locations, and pressure requirements with building water distribution and fire protection systems.

I. Contractor shall ensure that clearances in accordance with Northshore Utility District standardsare provided at crossings with other utilities.

1.9 REGULATORY REQUIREMENTS

A. Conform to requirements of WSDOT Standard Specifications for Road, Bridge and Municipal Construction, latest edition.

B. Conform to requirements of WSDOT Standard Plans for Municipal Construction, latest edition.

C. Conform to Northshore Utility District requirements– Water and Sewer Specifications and Standard Plans.

D. The building's fire sprinkler system requires separate permit from the City of Kenmore and the Northshore Fire Department. Contractor shall submit appropriate documents, prepared by a licensed designer, to all jurisdictions requiring review and permit approval.

PART 2 - PRODUCTS

2.1 PIPES AND FITTINGS

A. Ductile Iron, Push-on-Joint or Mechanical Joint Pipe: Class 52, conforming to ANSI/AWWA C151/A21.51 with cement-lining and sealed in accordance with ANSI/AWWA C104/A21.4, 4-inch diameter and larger. Each length of pipe shall be clearly marked with the manufacturer's identification, year, thickness, class of pipe, and weight. See Northshore Utility District – Water Specifications for allowable manufacturers. Pipe with push-on joints shall be furnished with a single rubber ring gasket. All gaskets, including MJ, shall be lubricated to effect the seal. Pipe

with mechanical joints shall be furnished with a mechanical joint of the stuffing box type, including rubber gasket, iron gland, and high strength tee-head bolts and nuts to effect the seal.

Ductile iron pipe shall be encased with polyethylene encasement (8 mil thickness). Material and installation shall be in accordance with AWWA C105. Installation shall be in accordance with AWWA C105, Method A or C.

Restrained joint pipe shall be push-on joint pipe with U.S. Pipe “TR Flex” or U.S. Pipe “Field Lok” gaskets, or equal.

B. Polyethylene Plastic Service Pipe: Service pipe shall be PE4710 high density polyethylene, SIDR 7 iron pipe size with a 250 psi pressure rating. The pipe shall conform to ASTM D2239 and AWWA C901. At a minimum, the pipe pressure rating, SIDR, and ASTM classification shall be clearly printed on the pipe.

C. The Contractor shall furnish certification from the manufacturer of the pipe and gasket being supplied that the inspection and all of the specified tests have been made and the results thereof comply with the requirements of these Specifications.

2.2 JOINING MATERIALS

A. Ductile Iron Piping - The following materials apply:

1. Push-on Joints ANSI/AWWAC111/A21.11: Pipe with push-on joints shall be furnished with rubber gaskets and lubricant to provide water-tight seal.
2. Mechanical Joints: Pipe with mechanical joints shall be furnished with a mechanical joint of the stuffing box type, including rubber gasket, iron gland, and high strength tee-head bolts and nuts to provide water-tight seal.
3. Fittings: Ductile iron fittings shall be short-bodied, compact with a minimum pressure rating of 350 psi for mechanical joint fittings and 250 psi for flanged fittings. All fittings shall be cement-lined and conform to AWWA C153 for mechanical joint fittings and AWWA C110 for flanged fittings. All fittings shall have cement-lining conforming to ANSI/AWWA C104/A21.4. All mechanical joint fittings shall be restrained with EBAA Iron, Inc. “Mega-Lug” mechanical joint restraints, or approved equal. The fittings shall be furnished with flanged ends or mechanical joints as shown on the plans.
   a. Gaskets: Rubber, flat face, 1/8-inch-thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated or required by Northshore Utility District.
   b. Flange Bolts and Nuts: ASME B18.2.1, high-strength carbon steel, unless otherwise indicated or required by Northshore Utility District.
4. All deactivated water mains shall be capped with Romac EC501 End Cap Coupling or approved equal.
5. Pipe restraints: Restrained joints shall be push-on joint pipe and fittings. The push-on joint restraint device shall be ductile iron with a 350 psi working pressure and shall be U.S. Pipe TR FLEX or U.S. Pipe “Field Lok” gaskets, or approved equal. Where restrained joints are required, fittings shall be mechanical joint with a restraint device equal to EBAA Iron, Inc. Mega-Lugs.

B. Solid sleeve pipe couplings shall be long pattern sleeves constructed of ductile iron with a minimum pressure rating of 250 psi working pressure.

C. Flexible Pipe Couplings: shall be Long Pattern Hymax, or approved equal.

D. All deactivated watermains shall be capped with Romac EC501 End Cap Coupling or approved equal and concrete thrust block per NUD standards.

2.3 VALVES

A. Conform to WSDOT Standard Specifications for Road, Bridge and Municipal Construction, latest Edition.

B. Valve Boxes: Valve boxes shall be two-piece, cast-iron, East Jordan Iron Works: Valve Box Cover-06800209, Valve Box Top-85557016U, and Valve Box Bottom-85556024U. Valve Boxes shall be centered over the valve nut and raised perpendicular to road or finish grade elevation. Valve box piping shall be in true alignment to this axis. Consideration must be given where road and water main alignments vary to create optimum valve and valve stem extension operation.

C. Gate Valves: Gate valves shall be ductile iron-bodied valves with resilient wedge, non-rising stem with flanged ends or mechanical joint conforming to the latest version of AWWA Standard C515 and shall be NSF 61 approved. Valves shall have epoxy coating fusion bonded to all internal and external surfaces of the valve body and bonnet in compliance with AWWA C550. The wedge shall be fully encapsulated in rubber. The valves shall be non-rising stem, open to the left, equipped with standard 2” square operating nuts and O-ring seals at all joints. The operating stem shall be bronze with O-ring stem seals. Resilient wedge seated gate valves shall be American Flow Control Series 2500, Clow model 2638, Mueller 2360 series, Kennedy 7000 series, East Jordan FlowMaster,, or M&H Style 7000.

D. Butterfly Valves: Butterfly valves shall be ductile iron body of the tight closing rubber seat type with rubber seat either bonded to the body or mechanically retained in the body with no fasteners or retaining hardware in the flow stream. The valves shall be epoxy coated inside and outside. The valves shall meet the full requirements of AWWA C504, class 150 B, except the valves shall be able to withstand 200 psi differential pressure without leakage. The valves shall be equal to Pratt "Groundhog" or Mueller Lineseal III. Butterfly valves to be installed underground shall have sealed mechanical operators and 2" standard square operating nuts. Complete manufacturer's Specifications for the valves proposed for use shall be submitted to Northshore Utility District for approval.

E. Post Indicator Valve: Vertical type, UL 789, FM-approved with cast iron body, operating wrench, extension rod, adjustable cast iron barrel of necessary length for depth of valve. Provide tamper switch and associated wiring.

2.4 FIRE HYDRANT ASSEMBLY

A. Fire hydrants shall conform to AWWA Standard Specification C502 and be one of the following types:

1. Mueller Super Centurion
2. American Darling B-62-B
3. Clow Medallion
4. M & H 929
5. East Jordan Iron Works WaterMaster 5CD250

They shall be a rising stem compression-type which opens counter-clockwise, and closes with the pressure. The minimum main valve opening diameter shall be 5-1/4 inches, unless otherwise specified. The hydrant seat and hydrant seat retaining ring shall be bronze. All

external bolts, nuts, and studs shall be cadmium plated in accordance with ASTM A165 Type HS or rust-proofed by some other process approved by Northshore Utility District. Gaskets shall be of rubber composition.

B. Fire hydrants shall be equipped with one 5" pumper connection (Seattle Standard Thread) with Storz Adapter as required by those jurisdictions shown on the Standard Details. The hydrant shall include two 2-1/2" NST hose ports. Pentagon nuts or caps and operating stem shall measure 1-1/4" point to flat and shall open by turning to the left. Nozzle shall be fitted with renewable bronze nipples locked in place.

C. Fire hydrants shall be set plumb and ports shall be oriented towards vehicular-accessed driveways.

D. Fire hydrant piping from the main line valve to the hydrant base shall be restrained joint pipe or shall be restrained with stainless steel shackle rods and nuts.

E. Fire hydrants shall be coated with enamel paint in accordance with Northshore Utility District standards.

F. Conform to Northshore Utility District Standard Plans.

G. Fire Hydrant Guard Posts: Concrete fire hydrant guard posts, if required as directed by the Northshore Utility District, shall be made of precast reinforced concrete, nine (9) inches in diameter, six (6) feet long, or 8"x6"x6 feet long. The guard posts shall be coated white with enamel paint in accordance with the Fire Hydrant Assembly Standard Detail.

H. Temporary Hydrant Protection: Provide 2'x2'x4' concrete blocks on traffic sides of hydrants to provide minimum of 3 feet clearance around hydrants. Concrete blocks shall be removed from site at completion of project.

2.5 FIRE DEPARTMENT CONNECTION (FDC)

A. Fire Department Connection shall be UL listed, FM approved per Model 5731 as manufactured by Potter Roemer. Provide cast brass two-way body, with threaded inlets according to NFPA and matching local fire department hose threads, and threaded bottom outlet. Finish shall be polished chrome plated. Include lugged caps, gaskets, and chains; pin lugged swivel connection and drop clapper for each hose connection inlet and 18-inch-high brass sleeve.

B. Temporary FDC Protection: Provide 2'x2'x4' concrete blocks on traffic sides of FDC to provide minimum of 3 feet clearance around FDC. Concrete blocks shall be removed from site at completion of project.

2.6 BACKFLOW ASSEMBLIES

A. Backflow assemblies shall conform to the latest Washington State Department of Health requirements and the District's Cross Connection Control Program policies. All backflow assemblies under the jurisdiction of the District shall be installed at a location immediately downstream of the water meter or immediately downstream of the water service connection if no water meter is present. All backflow assemblies shall be installed per NUD requirements and per Standard Details. At a minimum, backflow assemblies shall be installed for the following uses: for fire systems, irrigations systems, and for facilities where the highest water use is 30 feet or more above the water meter location. Temporary placement of a properly

operating, spring-loaded, single check valve is required, when determined by the District, in order to use a construction meter and shall be located directly behind any meter designated as a “construction meter”. All permanent backflow assemblies shall be tested by a Washington State certified Backflow Assembly Tester (BAT) upon installation, and at least annually thereafter. All initial backflow assembly testing shall be conducted in the presence of a District cross-connection control specialist. Complete manufacturer's specifications for the backflow assembly proposed for use shall be submitted to NUD for approval.

2.7 METER BOXES

A. Meter boxes shall be according to Northshore Utility District Standard Details.

2.8 SERVICE SADDLES

A. For ductile iron watermains larger than 4” diameter, direct tapping of 1” standard corporation stop threaded tap will be required. Saddles will not be allowed on ductile iron pipe larger than 4” diameter for 1” water services. Other service taps shall be as follows:

1. Service saddles for 1”, 1-1/2”, and 2” standard corporation stop threaded tap, shall be single strap and shall be equal to Mueller Company DR1S, Ford Meter Box Company FC101, or Romac Industries, Inc. 101NS.

2.9 SERVICE MATERIALS

A. Service materials including valves, pipe and fittings shall be as specified on the Standard Details. All brass appurtenances shall be “lead free” and conform to NSF/ANSI 372 and NSF/ANSI 61 standards. Two inch ball valves shall be furnished with a slotted operator, and with an adapting 2”-square operating nut (Ford Cat. QT-67) secured with a stainless steel cotter pin.

2.10 BLOW-OFFS AND AIR & VACUUM RELIEF VALVES

A. Two (2”) Blow-offs and one (1”) Air & Vacuum Relief Valves shall be installed for 12” diameter pipe and smaller in accordance with the standard detail. Blowoffs for pipe larger than 12” in diameter shall be as directed by Northshore Utility District.

2.11 REDUCED PRESSURE BACKFLOW ASSEMBLY AND ENCLOSURE

A. Three inch (3”) reduced pressure backflow assembly shall be Wilkins Model #375 AG or approved equivalent and installed in accordance with NUD Standard Water Detail 14. Installation shall be in accordance with the manufacturer’s recommendations. Provide heated Hot Box HB3ES enclosure or approved equivalent with sufficient insulation to prevent freezing.

2.12 STAINLESS STEEL TAPPING SLEEVE

A. Tapping sleeve shall be constructed of all stainless steel with removable, replaceable bolts and coated nuts to prevent galling. Gaskets shall provide a full circumferential seal. Tapping sleeve shall be Romac STS 420 Tapping Sleeve, JCM 432, or Ford FTSS stainless steel tapping sleeve or approved equal.

2.13 STEEL CASING

A. Steel casing pipe shall meet ASTM A-53, having a minimum tensile strength of 60,000 psi and a minimum yield strength of 35,000 psi. Wall thickness shall be sufficient to withstand jacking forces without deformation, with minimum wall thickness of 0.375 inches for casing pipe diameters up to 22". For casing pipe diameters larger than 22", please see the table at the end of this subsection. All joints shall be welded. All field-welded joints shall comply with AWS Code for procedures of manual shielded metal arc welding.

B. The carrier pipe shall be installed with casing spacers. Spacers shall be placed in accordance with the Methods of Construction and shall be at least 12-inches wide. Spacers shall be designed to provide a maximum space of 1-inch between the upper runners and the inside of the steel casing. The spacers shall prevent the pipe bells from touching the inside of the casing. Metal components of casing spacers shall be Type 304 (18-8) 14-gauge (minimum) stainless steel. The liner shall be neoprene rubber or PVC, and the runners shall be polyethylene with a low friction factor. Casing spacers shall be designed for center restraint. Casing spacers shall be Model CCS by Cascade Waterworks manufacturing, or District approved equal.

C. Where casing spacers must be custom designed to account for a specific grade of the carrier pipe inside the casing, submittals must be provided which include drawings and dimensions for each of the casing spacers and the respective location of each of the spacers relative to the casing and carrier pipe.

D. Casing end seals shall be 1/4-inch thick synthetic rubber with two stainless steel bands and clamps. The end seal shall be Model C by Pipeline Seal and Insulator, or APS Model AL, or approved equal.

Steel Casing Pipe Wall Thickness Table	
Diameter of Casing Pipe	Minimum Thickness
22" or Less	0.3750"
Over 22" – 28"	0.4375"
Over 28" – 34"	0.5000"
Over 34" – 42"	0.5625"
Over 42" – 48"	0.6250"
Over 48"	Review Required

2.14 CONCRETE THRUST BLOCKING

A. Thrust Block: Conform to plans. See Northshore Utility District – Water Standard Detail. Concrete blocking shall be 2,500 psi minimum strength, cast-in-place and have a minimum of ½ square foot bearing against the fitting.

2.15 IDENTIFICATION

A. Refer to Section 312000, "Earthwork" for excavation, trenching, backfilling and underground locating wire and warning tape materials.

B. Arrange for detectable warning tapes made of solid blue film with metallic core and continuously printed black-letter caption "CAUTION – WATER LINE BURIED BELOW."

C. Lettering shall be applied to all Fire Hydrants and Valve Marker Posts in accordance with Northshore Utility District – Water Standard Plans and Specifications.

2.16 EARTHWORK

A. Pipe Gravel Bedding
   1. Rigid Pipe: Bedding material for rigid pipe shall consist of imported gravel backfill, crushed rock, or controlled density fill as indicated on the plans or as directed by the Northshore Utility District. Contractor shall provide submittal of pipe bedding material for approval by NUD and the Engineer.
   2. Water Service Pipe: Bedding material shall consist of 100% clean sand. Native material will not be allowed by the District.

B. Trench Backfill
   1. Native material may be used for trench backfill if the material meets the requirements of Section 9-03.14(2) of the 2016 Standard Specifications for Road, Bridge and Municipal Construction of the Washington State Department of Transportation for Select Borrow. Native material shall be free from wood waste, organic waste, coal, charcoal, and other extraneous or objectionable materials and shall have no material larger than 2” in diameter. The material shall be non-plastic and shall not contain more than 3 percent organic material by weight.
   2. Imported gravel backfill shall be a granular material conforming to Section 9-03.14(1) of the 2016 Standard Specifications for Road, Bridge and Municipal Construction of the Washington State Department of Transportation.
   3. Where designated on the Contract Drawings, as required by the roadway permitting agency or as directed by the District, the trench backfill shall be controlled density fill (CDF), as manufactured by Cadman, Inc., Product #110021, “Pro-Flow Trench Five Hour”, or District approved equal.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Refer to Section 312000, “Earthwork” for excavation and trenching.

B. Contractor shall take precautions to protect existing utilities on the project site. Protection work includes all temporary shoring to maintain soil stability relative to the existing water system.

3.2 PIPE APPLICATIONS

A. General: Use pipe, fittings, and joining methods for piping systems according to the applications in following paragraphs.

B. Transition couplings and special fittings with pressure ratings at least equal to pipe pressure rating may be used in applications below, unless otherwise indicated.

3.3 JOINT CONSTRUCTION

A. Ductile-Iron Piping, Gasketed Joints: According to AWWA C600 and for fire service piping, according to UL 194 and AWWA C600.

B. Flanged Joints: Align flanges and install gaskets. Assemble joints by sequencing bolt tightening. Use lubricant on bolt threads.

C. Threaded Joints: Thread pipes with tapered pipe threads according to ASME B1.20.1, apply tape or joint compound, and apply wrench to fitting and valve ends into which pipes are being threaded.

D. Pipe Restraints: Install according to manufacturer's requirements. Use sufficient number of pipe restraints both upstream and downstream of joint to ensure thrust is adequately restrained.

3.4 GENERAL PIPE REQUIREMENTS

A. General Locations and Arrangements: Drawings indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated, unless deviations to layout are approved by Engineer.

B. Install components with pressure rating equal to or greater than system test pressure.

C. Install piping free of sags and bends.

D. Install fittings for changes in direction and branch connections.

E. Conform to Northshore Utility District requirements.

3.5 PIPE INSTALLATION

A. Water-Main Connection: Connect to the existing watermain as directed by and according to the requirements of the Northshore Utility District.

B. Install ductile-iron piping according to AWWA C600 and for fire service piping, according to UL194 and AWWA C600.

C. Minimum cover over all water lines shall be 36 inches over the top of the pipe for 8-inch mains and smaller; 48 inches over the top of mains greater than 8 inches.

D. Comply with NFPA for fire protection.

E. All pipes shall be installed in accordance with these specifications and the instructions of the manufacturer subject to approval of the Northshore Utility District.

F. All pipe ends shall be square with the longitudinal axis of the pipe and any damage to the ends shall be cut off before installation, if approved by the Northshore Utility District. Where necessary to cut the pipe, the pipe shall be cut with approved cutting tools.

G. The pipe shall be laid in a straight grade through localized breaks in grade, the excavation shall be deepened gradually at changes in the finish grades so that there are no abrupt changes in pipeline grade. To maintain the required alignment, use short lengths and deflect the joints or use necessary bends. Each pipe section shall be carefully lowered into place in the trench after inspecting it for defects and removing any gravel or dirt, etc., from the interior of the pipe.

H. Where it is necessary to cross sanitary sewer or storm sewer trenches, all trench backfill shall be removed and replaced with mechanically compacted pit run material or CDF in order to provide a uniform support for the full length of the pipe.

I. A 10-foot horizontal separation must be maintained between all sanitary sewer lines and water lines. A 3-foot minimum horizontal separation shall be maintained between other underground utilities, unless otherwise approved. All pipe shall be kept free of gravel, dirt and other contaminants. Temporary pipe plugs must be installed at all exposed pipe ends at the end of each working day. The pipe plug must be a water-tight, mechanical device, and shall be cleaned thoroughly prior to installation.

3.6 CONCRETE BLOCKING INSTALLATION

A. Concrete blocking shall be 2,500 psi minimum strength, cast in place and have a minimum of 1/2 square foot bearing against the fitting. Blocking shall bear against fittings only and shall be clear of joints so as to permit taking up or dismantling joint. The Contractor shall install blocking which is adequate to withstand full test pressure as well as to continuously stand operating pressures under all conditions of service. For concrete blocking based upon a 250 psi test pressure, see Northshore Utility District Standard Details.

3.7 VALVE INSTALLATION

A. Gate and butterfly valves shall be set in the ground vertically and shall be opened and shut under pressure to check operation and, at the same time, show no leakage. Valves 8 inches and larger that are not flanged to other fittings shall be blocked in accordance with the Standard Blocking Details.

B. AWWA-Type Gate Valves: Comply with AWWA C600. Install underground valves with stem pointing up and with cast-iron valve box.

C. Post Indicator Valve: Coordinate installation with electrical plans to provide tamper switch and wiring as necessary.

D. Conform to Northshore Utility District requirements.

3.8 FIRE HYDRANT INSTALLATION

A. Fire hydrant shall be set as shown in the Northshore Utility District Standard Detail. Mega-lugs or stainless steel tie rods shall be used to restrain the ductile iron pipe between the hydrant foot and the 6" hydrant valve.

B. The hydrant shall be set on a solid concrete block 4"x8"x16" and a minimum of 6 cubic feet of clean gravel shall be placed around the base of the hydrant for a drain pocket.

C. Fire hydrants shall be set plumb and with the ports oriented as directed by the Fire Protection District having jurisdiction over said area.

D. In some instances, it may be necessary to make a cut or provide a fill to set a hydrant. Where this occurs, the area for at least a three (3) foot radius around the hydrant shall be graded and leveled, and the cut slopes or fill slopes shall be neatly graded by hand, unless otherwise approved by Northshore Utility District and the Fire Marshal.

E. No tool other than an approved hydrant-operating wrench shall be used when operating hydrants.

F. Fire hydrants shall be prime-coated and finish coated in accordance with the Standard Detail.

3.9 GUARD POST INSTALLATION

A. Fire hydrant guard posts shall be installed if indicated on the plans or specified by Northshore Utility District. Guard posts shall be set with the top of the guard posts level with bonnet flange of the fire hydrant. They shall be plumb, and where two posts are used at a hydrant, they shall be set with their tops at the same elevation. The posts shall be coated in the same manner and with the same color as the fire hydrants.

3.10 VALVE BOX INSTALLATION

A. Valve boxes shall be set flush to the adjacent finished grade.

B. For valves located outside of paved areas, a cement or asphalt pad for the valve box shall be constructed according to the Standard Detail. The cement or asphalt pad shall be provided for all valves, unless otherwise directed.

3.11 AIR AND VACUUM RELIEF VALVE INSTALLATION

A. Air and vacuum relief valve assembly shall be installed as shown on the Northshore Utility District Standard Detail.

B. Location of the air release valves shall be at the high points of the line. Water line must be constructed so that the air release valve may be installed in a convenient location.

3.12 2-INCH BLOW-OFF INSTALLATION

A. 2” Blow-offs shall be installed for 12” diameter pipe and smaller in accordance with the Standard Detail.

3.13 LOCATING WIRE

A. All water mains and water services installed shall have 14-gauge solid copper wire with polyethylene coating. Wire shall be placed in the trench over the water main and the ends brought up into the valve boxes per the Standard Detail. Locating wire shall also be wrapped around the water service line and brought up into the meter box. All connections or splicing shall be made with District approved split-bolt wire connectors.

3.14 WATER SERVICE INSTALLATION

A. All service installations shall be according to the Northshore Utility Standard Details.

3.15 HYDROSTATIC TESTS

A. After backfilling the water main with sufficient material to prevent movement of the pipeline and allowing sufficient time for the concrete blocking to set, the water main shall be pressure tested in convenient lengths as directed by Northshore Utility District. In general, new mains shall be tested between valves and large sections of untested main shall not be permitted to

accumulate. The pipeline shall be filled by Northshore Utility District with water slowly and air expelled from the pipeline prior to starting the test. All pipelines shall be tested at a hydrostatic pressure of 250 psi at high point. All necessary pump, valves, meter gauges, piping, 2" blow-offs, hose and labor required shall be furnished by the Contractor. The pressure tests shall be performed in the following manner:

1. Water shall be pumped into the main, bringing the pressure in the main up to the required test pressure. After a period of one hour, water shall again be pumped into the main to bring the pressure up to the required test pressure and the quantity of water used during the test shall be accurately measured through a standard water service meter with a sweep unit hand that registers one gallon per revolution. The meter shall be approved by Northshore Utility District prior to any testing. The allowable water consumption shall not exceed the quantities as shown in the following table:

Allowable Water Consumption

Pipe Diameter (inches)	Allowable Water Leakage (gallons per hour/1000 feet of pipe)
2	0.21
4	0.42
6	0.63
8	0.84
12	1.26
16	1.68
18	1.89
Larger Sizes	As determined by District

2. All visible leakage shall be corrected and all new valves installed under these specifications shall be tight.
3. Any pressure drop during the test period shall not be abrupt under any circumstances and Northshore Utility District shall be the sole judge as to whether the pressure drop is acceptable for the conditions existing in the pipeline being tested. Whenever repairs or corrections are necessary, the pressure test shall be repeated to provide acceptability.

3.16 STERILIZATION AND FLUSHING OF WATER MAIN

A. Upon successful completion of the hydrostatic test, all new water mains and repaired portions of, or extensions to, mains shall be flushed and sampled for purity per AWWA C651-14. Northshore Utility District shall collect two consecutive samples for testing taken 24 hours apart and shall forward the bacteriological test results to the Contractor. Only upon receipt of two satisfactory bacteriological reports shall the Contractor be allowed to make connections to the existing main.

B. Water supply for filling, testing and flushing of the new mains shall be available from the existing distribution system. The Contractor shall make arrangements with Northshore Utility District for the necessary flushing of the pipeline. Opening of valves and use of water from Northshore Utility District's system shall be done by Northshore Utility District and water for flushing shall be provided by Northshore Utility District.

C. Taps required by the Contractor for temporary or permanent release of air, chlorination or flushing purposes shall be provided by the Contractor as a part of the construction of water mains. See NUD Standard Water Detail #17 for more information.

1. Dechlorination and Disposal Of Treated Water: Unless otherwise specified, the Contractor shall be responsible for disposal of treated water flushed from mains and shall neutralize the wastewater for protection of aquatic life in the receiving water before disposal into any natural drainage channel.
2. Requirement Of Chlorine: Before being placed into service, all new mains and repaired portions of, or extensions to, existing mains shall be chlorinated by the Contractor so that a chlorine residual of not less than 10 ppm remains in the water after standing 24 hours in the pipe. The initial chlorine content of the water shall be not less than 50 ppm.
3. Form and Method of Applied Chlorine: Chlorine shall be applied by one of the following methods, to give a dosage of not less than 50 ppm of available chlorine.
    a. Dry Calcium Hypochlorite: As each length of pipe is laid, sufficient high test calcium hypochlorite (65-70% chlorine) shall be placed in the pipe to yield a dosage of not less than 50 ppm available chlorine, calculated on the volume of the water which the pipe and appurtenances shall contain. The number of ounces of 65% test calcium hypochlorite required for a 20-foot length of pipe equals 0.008431D2, in which "D" is the diameter in inches.
    b. Liquid Chlorine: A chlorine gas-water mixture shall be applied by means of a solution feed chlorinating device, or the dry gas may be fed directly through proper devices for regulating the rate of flow and providing effective diffusion of the gas into the water within the pipe being treated. Chlorinating devices for feeding solution of the chlorine gas, or the gas itself, must provide means for preventing the backflow of water into the chlorine.
    c. Chlorine-Bearing Compounds In Water: A mixture of water and high-test calcium hypochlorite (65-70% Cl) may be substituted for the chlorine gas-water mixture. The dry powder shall first be mixed as a paste and then thinned to a 1 per cent chlorine solution by adding water to give a total quantity of 7.5 gallons of water per pound of dry powder. This solution shall be injected in one end of the section of main to be disinfected while filling the main with water.
    d. Sodium Hypochlorite: Sodium hypochlorite, commercial grade (15% Cl) or in the form of liquid household bleach (5% Cl) may be substituted for the chlorine gas-water mixture. This liquid chlorine compound may be used full strength or diluted with water and injected into the main in correct proportion to the fill water so that dosage applied to the water shall be at least 50 ppm.
4. Preventing Reverse Flow: During flushing, filling and testing, Northshore Utility District shall make the connections to the existing distribution system and the new water pipelines and shall utilize a backflow prevention device approved by the State Department of Health.
5. Retention Period: Treated water shall be retained in the pipe for a minimum of 24 hours and a maximum of 48 hours. After this period, the chlorine residual at pipe extremities and at other representative points shall be at least 10 parts per million.
6. Chlorinating Valves and Hydrants: In the process of chlorinating newly-laid pipe, all hydrant valves and other appurtenances shall be opened while the pipeline is filled with the chlorinating agent and under normal operating pressure.
7. Chlorinating Final Connections to Existing Water Mains And Service Connections: The chlorinating procedure to be followed shall be as specified by AWWA. All closure fittings shall be swabbed with a 50 ppm minimum chlorine solution.
8. Final Flushing and Testing: Before placing the lines into service, two consecutive satisfactory bacteriological test reports shall be received.
9. Repetition of Flushing and Testing: If the initial round of bacteriological testing, two consecutive tests as outlined previously, result in an unsatisfactory outcome, and repeat flushing and testing that is completed by NUD shall be paid for by the Contractor. If the second round of bacteriological tests results in an unsatisfactory outcome, rechlorination of the installed watermain shall be required either by the continuous-feed method or slug

method as outlined in AWWA C651-14. The costs for subsequent redisinfection and testing shall also be the responsibility of the Contractor.

3.17 CONNECTION TO EXISTING WATER MAIN

A. The Contractor shall not operate any gate valves on the water system. Connections to the existing main shall not occur until satisfactory purity tests have been obtained and without approval of Northshore Utility District.

B. The Contractor shall make the necessary arrangements with Northshore Utility District for the connection to the existing water main.

C. Water service outages shall be limited to the hours of 8:00 AM to 3:30 PM in order to minimize inconvenience to water users and maintain fire protection for the area. Once work is started on the connection, it shall proceed continuously without interruption and as rapidly as possible until completed. The Contractor shall provide a minimum of 72 hours notice to Northshore Utility District prior to the required shutdown. Northshore Utility District shall alert affected property owners of the proposed service interruptions.

D. Existing mains shall be kept in operation until the new main has been constructed, satisfactorily tested and disinfected and is ready for operation. Connections to the existing system shall then be made.

E. All material used for the connection shall be thoroughly sterilized by swabbing the interior with a chlorine solution of 50 ppm.

3.18 STEEL CASING

A. Steel casing shall be in accordance with the Part 2 section of this Specification.

B. Sizing and wall thickness of casing shall be approved by Northshore Utility District.

C. If excess voids are created around the casing, holes shall be drilled through the casing and the voids shall be pumped full of cement grout. All excess excavated material shall be disposed of in a manner acceptable to Northshore Utility District and permitting agencies.

D. The carrier pipe shall be supported on casing spacers at 10 ft. maximum spacing and shall be installed with restrained joints. See the Engineering Specifications, Materials of Construction and the Standard Detail for additional information.

3.19 EXCAVATION AND BACKFILL

A. Temporary Traffic Control: The Contractor shall make suitable, safe, and adequate provision for necessary traffic around, over, or across the work in progress and shall schedule pavement patching to follow after backfill is completed as directed by regulatory agency. The Contractor shall submit a traffic control plan for review and approval by Northshore Utility District and the permitting agency prior to beginning work. Traffic control shall conform to Section 1-10 of the 2016 Standard Specifications for Road, Bridge and Municipal Construction of the Washington State Department of Transportation.

B. Excavating In Paved Areas: Prior to excavating in paved areas, the existing road surface shall be cut a minimum of 1' back from the outer edge of the excavation with approved cutting

equipment. The cuts are to be made in clean, straight lines to insure a minimum of damage to the existing pavements. All cuts in existing concrete pavement are to be made with a concrete saw, except that where the concrete has been overlaid with asphalt, the pavement may be drilled on three (3) inch centers 1' (minimum) from the outer edge of the excavation on each side of the trench section. If the Contractor fails to adequately protect the cut edges during construction, the Contractor shall be required, at their own expense, to re-cut the edges a minimum of 1’ back from the edge of excavation prior to repairing the pavement.

C. Trench Safety and Excavation: Contractor shall provide and install trench safety systems such as shoring or trench boxes or shall employ construction techniques such as back sloping that meet the applicable State and Federal safety regulations. Use and removal of trench safety systems shall be accomplished in such a manner that there shall be no damage to the work or to the other properties. Maximum and minimum trench widths shall be in accordance with the dimensions shown on the Standard Details. In all cases, trenches must be of sufficient width to permit proper joining of the pipe and backfilling of material along the sides of the pipe. Trench width at the surface of the ground shall be kept to the minimum amount necessary for proper installation of the work in a safe manner. Trenches wider than the maximum specified may result in a greater load on the pipe and, consequently, if the maximum trench width is exceeded by the Contractor, the Contractor shall, at their own expense, provide pipe of higher strength classification or provide a higher class of bedding where necessary to assure that the pipe shall not be overloaded. The maximum length of open trench permissible on any line, in advance of pipe laying, shall be 100 feet for sewer pipe and 250 feet for water mains, except at the end of each day's operations, there shall be no trench in which pipe laying, embedment and backfill have not been completed. Upon completion of work each day, all open trenches shall be completely backfilled, leveled and temporarily patched, graveled, fenced, or sheeted as required by the regulatory agency and Northshore Utility District.

D. Excavation for manholes, valves, structures and other appurtenances shall be sufficient to provide enough room for compaction equipment between the outside surfaces and the sides of the excavation.

E. All material excavated from trenches and stored adjacent to trench or in a roadway or public thoroughfare shall be maintained in such manner that shall cause a minimum of inconvenience to public travel. Provisions shall be made for traffic where such is necessary. Free access shall be provided to all fire hydrants, water valves, and meters and clearance shall be left to enable the free flow of storm water in all gutters, conduits, and natural water courses. Where the trench bottom is a material which is unsuitable for providing an adequate foundation or material which shall make it difficult to obtain uniform bearing for the pipe such material shall be removed and replaced with “foundation gravel" as directed by NUD.

F. Pipe Bedding and Trench Backfill: The placement and compaction of the pipe bedding and trench backfill shall be in accordance with the requirements of the various applicable sections of these specifications and as shown on Standard Details.
   1. Where excavated material is not approved for backfill or bedding, imported backfill gravel shall be provided.
   2. Where governmental agencies other than Northshore Utility District have jurisdiction over roadways, the backfill shall be in accordance with the agencies requirements.
   3. Bedding material shall be carefully placed and firmly compacted to provide a firm, uniform cradle for the pipe. The minimum thickness of the layer of bedding material required shall be 4 inches under the bell for all pipe sizes of 27 inches diameter and smaller, 6 inches for all pipe sizes 30 inches diameter and larger and 6 inches under the bell of the pipe for all diameter pipes where rock is excavated. The Contractor shall provide firm, continuous support for the pipe.

4. After the pipe laying operation, additional bedding material shall be placed and compacted by hand tools for the full width of the trench to a height of 6" above the top of the pipe.
5. In backfilling the trench, the Contractor shall take all necessary precautions to protect the pipe and protective coating from any damage or shifting of the pipe.
6. No timber bracing, lagging, sheathing or other lumber shall be left in any excavation.
7. At all roadway and driveway crossings and within existing paved rights-of-way and in such additional locations as may be directed by Northshore Utility District, the trench shall be immediately backfilled after the pipe is installed and inspected and shall be immediately provided with a temporarily graveled surface and continually maintained on a daily basis until replaced with permanent repair as required.
8. The Contractor shall be responsible for restoring to a condition equal to the prior condition of any and all existing utilities, culverts, ditches, drains, landscaping or other facilities which are damaged as a result of the Contractor's operation.

3.20 COMPACTION OF TRENCH BACKFILL

A. Trenching Parallel To Road Alignment: All trench backfill under roadway shall be mechanically compacted to 95% of maximum dry density. In any trench in which 95% density cannot be achieved with existing backfill, the existing backfill shall be replaced with imported gravel backfill as specified in the Earth Moving Specifications. The imported gravel backfill shall be mechanically compacted to 95% of maximum dry density for the full depth of the trench. All backfill material shall be compacted in 24” maximum lifts using heavy machinery or 12” maximum lifts using hand equipment.

B. Trenching Transverse To Road Alignment: For transverse trenching locations, such as side sewers and intersections, the entire trench shall be backfilled with 1-1/4“ minus crushed rock per the Engineering Specifications and placed in the maximum lifts listed above in Section 3.21A and compacted to 95% of maximum dry density. The moisture content of all soils used shall be within 2% of optimum. All densities shall be determined by the ASTM D-1557 (Modified Proctor) test procedure. All testing is to be provided and paid for by the Contractor. The Contractor shall coordinate the testing with Northshore Utility District and shall provide convenient and safe access to the site and the trench for sampling and testing.

3.21 REPLACING ROAD SURFACE

A. The Contractor shall restore all roadway and driveway surfaces and features excavated or disturbed to a condition acceptable to Northshore Utility District and the Owner.

B. All work in County right-of-way shall be subject to King County approval. All work in the City’s right-of-way shall be subject to approval by the City of Kenmore.

C. Paving restoration consists of two steps. The first step is installation of a temporary cold mix patch to be maintained until all work and other restoration is complete or up to 5 days. The second step is installation and sealing of the permanent pavement trench patch.

D. This work shall consist of the preparation, placing and compaction of subgrade and the patching of various types of pavement cuts to the complete resurfacing of roadways, the performance of which shall be in accordance with the requirements outlined herein. Roadway surface restoration and patching shall be in accordance with the 2016 Standard Specifications for Road, Bridge and Municipal Construction of the Washington State Department of Transportation, unless specifically directed otherwise by Northshore Utility District.

E. Before patching material is placed, all pavement cuts shall be trued so that marginal lines of the patch shall form a rectangle with straight edges and vertical faces a minimum of one (1) foot back from the maximum trench width.

F. The Contractor shall maintain proper signs, barricades, lights and other warning devices in accordance with the traffic control plan.

G. Gravel Base: Gravel base for road restoration shall conform to the Earth Moving specifications and shall be placed and compacted in conformance with Sections 2 and 9 of the 2016 Standard Specifications for Road, Bridge and Municipal Construction of the Washington State Department of Transportation. Gravel base shall be placed and compacted before succeeding course material is placed. Gravel base shall be used as shown on the plans or as directed by Northshore Utility District.

H. Asphalt Concrete Surfacing: Asphalt concrete surfacing or repair shall be asphalt concrete pavement, HMA Class ½" PG58-22, according to the Asphalt Paving Specifications and shall be placed in accordance with Section 5-04 the 2016 Standard Specifications for Road, Bridge and Municipal Construction of the Washington State Department of Transportation and the Standard Specification Drawing for Permanent Asphalt Concrete Patch. All edges and joints of asphalt concrete pavement repair shall be sealed with asphalt cement. After pavement is in place, all joints shall be sealed with SS-1, or equal.

I. Cement Concrete Pavement: Concrete shall be as specified in other specification sections and shall be placed in accordance with Section 5-05 of the 2016 Standard Specifications for Road, Bridge and Municipal Construction of the Washington State Department of Transportation. Concrete cylinder samples shall be taken by Northshore Utility District for the purpose of testing the compressive strength of the concrete to meet the standards as defined by the regulatory agency. Subgrades shall be prepared as shown on the plans and in compliance with the 2016 Standard Specifications for Road, Bridge and Municipal Construction of the Washington State Department of Transportation. All reinforcing steel shall conform with and be placed in accordance with Section 5-05 of the 2016 Standard Specifications for Road, Bridge and Municipal Construction of the Washington State Department of Transportation and shall conform to the requirements of ASTM Designation A-15 and A-305, latest revisions.

3.22 ADJUSTMENT OF NEW AND EXISTING UTILITY STRUCTURES TO GRADE

A. This work consists of constructing and/or adjusting all new and existing utility structures encountered on the project to finished grade.

B. The castings shall not be adjusted until the pavement is completed, at which time the center of each casting shall be relocated from references previously established by the Contractor. The pavement shall be cut as further described and base material removed to permit removal of the casting. The casting shall then be brought to proper grade.

C. Prior to commencing manhole adjustments, a plywood and visqueen cover, as approved by Northshore Utility District, shall be placed over the manhole base and channel to protect them from debris.

D. The asphalt concrete pavement shall be cut and removed to a neat circle, the diameter of which shall not exceed 6" from the outside diameter of the casting frame. The casting frame shall be brought up to desired grade, which shall conform to surrounding road surface. For manholes, adjustment to desired grade shall be made with the use of concrete adjustment rings or bricks. No iron adjustment rings shall be allowed. An approved class of mortar (one part

cement to two parts of plaster sand) shall be placed between adjustment rings or bricks and casting frame to completely fill all voids and to provide a watertight6seal. No rough or uneven surfaces shall be permitted inside or out. Adjustment rings or brick shall be placed and aligned so as to provide vertical sides and vertical alignment of ladder steps (if steps are necessary).

E. Check manhole specifications and the Standard Details for minimum and maximum manhole adjustment and step requirements. Special care shall be exercised in all operations in order not to damage the manhole, frames and lids or other existing facilities.

F. The annular space between the casting and the pavement shall be filled with crushed rock and compacted with hand tamper to within 6" of the top of the frame. Asphalt concrete patching shall not be carried out during wet ground conditions or when air temperature is below 50°. Asphalt concrete mix must be at the temperature as specified by the regulatory agency when placed. Before making the asphalt concrete repair, the edges of the existing asphalt concrete pavement and the outer edge of the casting shall be tack coated with hot asphalt cement. The remaining 6" shall then be filled with HMA ½" asphalt concrete and compacted with hand tampers and a patching roller.

G. The completed patch shall match the existing paved surface for texture, density and uniformity of grade. The joint between the patch and the existing pavement shall then be carefully painted with hot asphalt cement or asphalt emulsion and shall be immediately covered with dry paving sand before asphalt cement solidifies. Before acceptance of a job, castings shall be cleaned of all debris and foreign material. All ladders must be cleaned free of grout. Any damage occurring to the existing facilities due to the Contractor's operations shall be repaired at their own expense.

3.23 IDENTIFICATION INSTALLATION

A. Install continuous plastic underground warning tape during back-filling of trench for underground water-service piping. Locate 6- to 8-inches below finished grade, directly over piping.

B. Install locating wire directly over non-ferrous pipe.

3.24 FIELD QUALITY CONTROL

A. Pressure and purity testing shall be done in the presence or, and under the supervision of, a Northshore Utility District Inspector. Conform to Northshore Utility District requirements for pressure and purity testing.

B. Prepare reports for testing activities and submit to Northshore Utility District and Engineer.

3.25 FINISHING AND CLEANUP

A. Before acceptance of the project, all pipes, manholes, catch basins, and other appurtenances shall be cleaned of all debris and foreign material. After all other work on the project is completed and before final acceptance, the entire roadway, including the roadbed, planting, sidewalk areas, shoulders, driveways, alley and side street approaches, slopes, ditches, utility trenches, and construction areas shall be neatly finished to the lines, grades and cross-sections shown on the plans and as hereinafter specified.

B. In undeveloped areas, the entire area which has been disturbed by the construction shall be shaped so that, upon completion, the area shall present a uniform appearance, blending into the contour of the adjacent properties. All other requirements outlined previously shall be met. Slopes, sidewalk areas, planting areas and roadway shall be smoothed and finished to the required cross-section and grade.

C. Upon completion of the cleaning and dressing, the project shall appear uniform in all respects. All graded areas shall be true to line and grade as shown on the typical sections and as required by Northshore Utility District.

D. All rocks in excess of one (1) inch diameter shall be removed from the entire construction area and shall be disposed of the same as required for other waste material. In no instance, shall the rock be thrown onto private property. Overhang on slopes shall be removed and slopes dressed neatly so as to present a uniform, well sloped surface.

E. All excavated material at the outer lateral limits of the project shall be removed entirely. All debris resulting from clearing and grubbing or grading operations shall be removed and disposed.

F. Drainage facilities, such as inlets, catch basins, culverts, and open ditches, shall be cleaned of all debris resulting from the Contractor's operations.

G. All pavements and oil mat surfaces, whether new or old, shall be thoroughly cleaned. Existing improvements, such as Portland cement concrete curbs, curb and gutters, walls, sidewalks, and other facilities which have been sprayed by the asphalt cement shall be cleaned to the satisfaction of Northshore Utility District.

H. Castings for manholes, monuments, water valves, lamp poles, vaults, and other similar installations which have been covered with the asphalt material shall be cleaned to the satisfaction of Northshore Utility District.

END OF SECTION 331110

SECTION 333100 – SANITARY SEWER

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. Work of this Section includes but is not limited to the following:

1. Pipes and associated infrastructure for sanitary sewerage system outside buildings.
2. Sanitary sewer manholes.
3. Manhole vacuum testing.
4. Testing gravity sewer systems.
5. Side sewer installation.
6. Connection to existing sewer systems.
7. Temporary utility connections.

B. Related Sections include the following:

1. Section 312000, “Earthwork” for trench excavation, bedding, and backfilling.

1.3 REFERENCE STANDARDS

A. Northshore Utility District – Water and Sewer Specifications, latest edition.

B. WSDOT Standard Specifications for Road, Bridge and Municipal Construction, latest edition.

C. WSDOT Standard Plans for Road, Bridge and Municipal Construction, latestedition.

D. Conform to OSHA (Occupational Safety and Health Act) and WISHA (Washington State Industrial Safety and Health Act) requirements for trench safety.

1.4 DEFINITIONS

A. PVC: Polyvinyl chloride plastic.

1.5 SUBMITTALS

A. Submit under provisions of Section 013300, “Submittal Procedures” and as further provided.

B. Submittals that have been submitted and approved shall be available onsite for reference by the Owner and Engineer.

C. Certification:

1. Provide a letter, signed by the supplier and reviewed and also signed by an officer of the Contractor’s company, certifying that the following products to be incorporated into the - work meet the requirements specified.

2. All product submittals shall be submitted to the Engineer and the Northshore Utility District (NUD) for review and approval. Contractor shall deliver submittals to NUD. Sewer system construction shall not commence until all submittals have been approved by the Engineer and NUD.
3. Products:
   a. Pipes, gaskets, and fittings
   b. Cleanouts
   c. Flexible Coupling Adapters
   d. Manholes with Base Liners (Standard and Shallow)
   e. Frame and Cover
   f. Watertight Manhole Casting and Frame and Manhole Collar
   g. Manhole Adapters
   h. Steps and Ladder

D. Field Test Reports: Provide and interpret test results for compliance with performance requirements.

E. Television Inspection Report: Prepared by a firm licensed to perform such analysis, submitted to the Architect a minimum of 30-days before final surfacing construction is scheduled. The following shall be submitted:

1. Inspection shall be accomplished using a 360-degree radial view color television camera.
2. Video recording of constructed conditions of pipes, joints, and structures.
3. Written report documenting stations of sags, improper joints, connections or other areas of concern. Contractor shall provide a written proposal for repairs to mitigate all areas of concern or non-conforming conditions.

F. Record drawings according to Section 017700, “Closeout Procedures” and Section 017839, “Project Record Documents.”

1. Record information shall be provided by a Professional Land Surveyor that is licensed in the State of Washington.
2. Minimum record information shall include utility field changes during construction and indicating as-constructed conditions and elevations to meet Northshore Utility District standards.

1.6 DELIVERY, STORAGE AND HANDLING

A. Do not store plastic structures, pipe, and fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

C. Handle pre-cast concrete structures according to manufacturer’s written rigging instructions.

1.7 PROJECT CONDITIONS

A. Site Information: Perform site survey, research public utility records, and verify existing utility locations.

B. Existing Utilities: Utility interruptions shall not be allowed during occupied hours unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Architect not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect's written permission.
3. Project requires new connections to existing sewers.
   a. Contractor is responsible for all demolition, trenching, bedding, pipe installation, backfill, compaction, and final surfacing.
   b. Work includes any temporary pumping of existing sewer flows to allow construction of new sewer system.

1.8 SEQUENCING AND SCHEDULING

A. A preconstruction meeting shall be held with Northshore Utility District prior to any construction.

B. Phasing of construction may require the Contractor to construct temporary systems to maintain sewer service. Contractor shall expect and plan for encountering such occurrences and making adjustments to the alignments and configurations of systems to minimize disruption to the Owner's use of premises.

C. Utility interruptions shall not be allowed during occupied hours unless permitted under the following conditions and then only after arranging to provide temporary utility services according to the following requirements:

   1. Notify Architect/Owner/City/NUD not less than two days in advance of proposed utility interruptions.
   2. Do not proceed with utility interruptions without Architect's/Owner's written permission.
   3. Contact utility-locator service for area where work shall be performed to confirm the presence of all known existing utilities.

D. Coordinate connections to sewer main with Northshore Utility District.

E. Provide temporary connections to existing and new sewer systems as necessary to address sewer service and for other construction phasing requirements.

F. Coordinate pipe materials, sizes, and entry locations with building sewer system.

G. Contractor shall ensure that clearances in accordance with Northshore Utility District standards are provided at crossings with other utilities.

1.9 REGULATORY REQUIREMENTS

A. Conform to the Northshore Utility District Water and Sewer Specifications.

B. Conform to applicable codes for materials and installation of the Work of this section. Codes include, but are not limited to, the Uniform Plumbing Code (UPC).

C. Conform to WSDOT Standard Specifications for Road, Bridge, and Municipal Construction, latest edition.

D. Field Survey of constructed facilities shall be by a surveyor licensed in Washington State.

E. Provide temporary connections to sewer system as necessary to maintain service to existing buildings and for other construction phasing requirements.

PART 2 - PRODUCTS

2.1 PIPES AND FITTINGS

A. PVC Gravity Sewer Pipe and Fittings: PVC gravity sewer pipe and fittings in sizes 6-inch through 12-inch shall be integral wall bell and spigot, rubber gasket joint, plasticized polyvinyl chloride (PVC) pipe in conformance with ASTM D3034 and shall have a wall thickness of SDR 35. PVC pipe shall have a minimum "pipe stiffness" of 46 psi at 5 percent deflection when tested in accordance with ASTM Designation D2412 and a minimum impact strength of 210 foot-pounds based upon ASTM D3034. All pipes shall be clearly marked with the manufacturer's identification, year, and class of pipe. All fittings and accessories shall be manufactured and furnished by the pipe supplier, or shall be Northshore Utility District approved equal. Pipe joints shall use flexible elastomeric gaskets conforming to ASTM D3212. Connections for side sewer stubs shall be 6 inches inside diameter tee fittings. Wye branches shall be used where the sewer line size is less than 8 inches inside diameter.

B. DUCTILE IRON SEWER PIPE AND FITTINGS

1. Ductile iron pipe shall be new, Class 52, cement-lined, conforming to AWWA C151.
2. Ductile iron pipe shall be push-on joint. Pipe shall be furnished with a single rubber ring gasket lubricated to effect the seal.
3. Restrained joint pipe shall be push-on joint pipe with U.S. Pipe "TR Flex" or U.S. Pipe "Field Lok" gaskets, or approved equal. Each length of pipe shall be clearly marked with the manufacturer's identification, year, thickness, class of pipe and weight.
4. The Contractor shall furnish certification from the manufacturer of the pipe and gasket being supplied that the inspection and all of the specified tests have been made and the results thereof comply with the requirements of this standard.
5. Ductile iron fittings shall be short body with a 350 psi pressure rating for mechanical joint fittings and 250 psi for flanged fittings. All fittings shall be cement lined and shall be in conformance with AWWA C153.

C. FLEXIBLE COUPLING ADAPTERS

1. Flexible coupling adapters shall meet the specifications set forth in the AWWA Standard C219 coupling specification and be rated for working pressures up to 250 psi. Flexible coupling adapters shall be Romac XR501, Hymax 2000, or Northshore Utility District approved equal.

2.2 SANITARY SEWER MANHOLE

A. Conform to Northshore Utility District Sewer Specifications and Sewer Standard Plan No. 2. Manholes shall be of the offset type, shall be precast concrete sections with a precast base, and shall be made from 3,000 psi structural concrete. All manhole joints shall be watertight and shall be confined O-ring type. They shall be constructed in full compliance with the Standard Details and as further specified herein. Manhole materials and manufacturing shall be in accordance with ASTM C478. The base sections and risers of the manholes shall be arranged so no pipes pass through the manhole joints.

1. Manhole Sections: Manhole sections shall be placed and aligned so as to provide plumb vertical sides and vertical alignment of the ladder steps. The completed manhole shall be rigid, true to dimension and be watertight. The ladder shall be rigidly attached to the side of the manhole. Manhole grade rings shall be reinforced 3,000 psi structural concrete, 24 inches in diameter and 4 inches high. Grade rings shall be set in a full width bed of cement

grout. Provide grout between rings and between upper ring and casting. Inside rings shall be troweled smooth with 1/2" (minimum) of grout in order to provide a watertight surface. In addition to the O-ring rubber gaskets, all new manhole joints shall be sealed with a flexible butyl joint sealant conforming to ASTM C990-96 and Federal Specification SS-S-210. The flexible butyl joint sealant shall be “Kent Seal #2” as manufactured by Hamilton-Kent Company or “Ram-Nek” as manufactured by K.T. Snyder Company. Steel lifting loops or hooks for precast manhole components shall be removed to a minimum depth of one (1) inch below the surface and the remaining hole packed with grout. Precast sections with damaged joint surfaces or with cracks or other damage that may permit infiltration shall not be allowed. Reinforcement for precast manholes shall be in accordance with ASTM C 478-97.

Base Liners: All new manholes shall be installed with prefabricated manhole base liner made of polypropylene and/or fiberglass reinforced plastic (FRP). The base liner shall be integrally cast and adequately anchored inside new precast concrete manhole base sections during the concrete casting process at the manhole supplier’s manufacturing facility. The base liner shall be cast integral with the precast concrete manhole base section in accordance with the liner manufacturer’s specifications. The liner must be fully supported during the casting process and lifting devices shall not penetrate the base liner. The manhole base liner shall be prefabricated from a one-piece homogenous composite and/or thermoplastic with minimum thickness of 0.12” (3 mm) and shall be in lengths and nominal inside diameters corresponding to the precast concrete base section and be a non load-bearing component, which is resistant to the chemical environment normally found in wastewater collection systems. The outer surface of the liner shall be coated with aggregate and/or polypropylene pellets bonded to the outer surface and have perforated polypropylene I-beam “bonding bridge” anchors bonded to the outer surface in order to insure adequate anchoring to concrete base sections to pass vacuum testing with 10” of negative pressure. The inside liner surfaces shall be free of bulges, dents and other defects that result in a variation of inside diameter of more than 1/4” (7 mm) for base liner flow channel and pipe connections. The precast concrete pipe penetration joint surfaces shall be free of excess concrete at external and internal surfaces to insure a proper seal between the pipe connection and the liner. The manhole base liner shall include full flow channels with side-walls to the crown of the pipe. The inner surface of the bench shall be provided with an anti-skid pattern. Watertight gasketed pipe bell connections to suit specific pipe types, grade and alignment, shall be monolithically attached to the base liners and shall extend to the outside profile of the precast concrete structure. Base liner properties shall be in accordance NUD specifications. Base liners shall be manufactured and supplied by Predl Systems North America of Burnaby, B.C.

2. Manhole Steps: Manhole steps shall be made of ½” Grade 60 Steel reinforcing bars coated with copolymer polypropylene, equal to Lane International Manhole Step No. P-14850. The steps shall be installed at the manhole manufacturer’s yard in conformance with the step manufacturer requirements. At a minimum, the step ends shall be coated with non-shrink epoxy grout and driven into predrilled holes with dimensions of 1” inch diameter and 3-1/2” depth. The pre-drilled holes shall not penetrate the exterior manhole wall.
3. Grade Adjustment: The depth of the 24” diameter manhole neck from the top of the frame to the top of the cone shall be from between 14” and 26”.
4. Channels: All new manholes shall be provided with fiberglass reinforced plastic base liners per Subsection of these specifications, unless otherwise indicated on the plans or approved by Northshore Utility District. Manholes approved for cement concrete channels shall conform to this subsection of the specifications. Channels shall be made to conform accurately to the sewer grade and shall be brought together smoothly with well-rounded junctions, subject to approval by Northshore Utility District. Channels shall consist of commercial grade concrete, minimum Class 3000 in accordance with Section 6-02 of the 2016 Standard Specifications for Road, Bridge and Municipal Construction of the

Washington State Department of Transportation. The channels shall be field poured after the inlet and outlet pipes have been laid and firmly grouted into place at the proper elevation. Allowances shall be made for a minimum of one-tenth foot (0.1') drop in elevation across the manhole in the direction of flow. The maximum allowable drop in inlet elevation across the manhole in the direction of flow shall be 0.5 ft. Channel sides shall be carried up vertically from the invert to three-quarters of the diameter of the various pipes. The concrete bench shall be warped evenly and sloped two percent (2%) to drain. Rough, uneven surfaces shall not be permitted. Channels shall be constructed to allow the installation and use of a mechanical plug of the appropriate size.

5. Pipe Connections: All pipe entering or leaving the manhole shall be placed on firmly compacted bedding. Special care shall be taken to see that the openings through which pipes enter the structure are completely and firmly filled with mortar from the outside to insure water-tightness. All PVC pipe connections to manholes shall be made with GPK PVC Manhole Adapters (also known as “sand collars”) with an external abrasive silica layer or Kor-N-Seal Connector manufactured by NPC. Inc. All stubbed out sewer pipes placed through manhole walls for future connections shall be suitably plugged and blocked in a manner acceptable to Northshore Utility District.
6. Shelf Repairs: Shelf repairs at connections to the existing manholes shall be class 3000 commercial grade cement in accordance with the Engineering Specifications.
7. Grout: Grout for all uses including, but not limited to, manhole channels, shelves, pick-holes, and adjusting rings, shall be cement based, nonshrink, noncorrrosive, and nonmetallic grout conforming to ASTM C 1107. Grout shall be Dayton Superior 1107 Advantage Grout, Basalite Nonshrink Grout – Fast Set, SpecChem SC Multipurpose Grout, or Quikrete Commerical Grade FastSet Nonshrink Grout, or approved equal. Northshore Utility District may sample and test grout to determine conformance with the specifications.
8. Drop Manholes: Drop manholes shall, in all respects, be constructed as a standard manhole with the exception of the drop connection as shown on the Standard Detail.
9. Lift Holes: All lift holes shall be completely filled smooth with grout both inside and out in order to insure water-tightness.
10. Manhole Certification: The Contractor shall provide written certification from the manhole manufacturer that the manholes provided meet or exceed the specifications and that the materials used in the construction of the manhole are in accordance with the specifications. A Manufacturer’s Certificate of Compliance shall be provided for each manhole delivered to the project and shall include the manufacturer’s name and address, Northshore Utility District’s manhole number, reference to the applicable project specifications being used, the design mix and 28-day strength of the cement concrete used, drawings indicating reinforcing steel details, such as size and location, results of materials testing conducted by the manufacturer and the signature of a responsible corporate official of the manufacturer. Northshore Utility District may test manholes and materials used at any time, including after installation, and any manhole not conforming to the specifications shall be rejected by Northshore Utility District and replaced with a conforming manhole provided and installed by the Contractor.

2.3 MANHOLE AND CLEANOUT FRAME AND COVERS

A. Frames and covers shall be cast iron and conform to the Standard Details and these specifications. Castings shall conform to the requirements of ASTM A-48, Class 30 and shall be free of porosity, shrink cavities, cold shuts or cracks, or any surface defects that would impair serviceability. Repair of defects by welding, or by the use of smooth-on or similar material, shall not be permitted. Frames and covers shall be machine-finished or ground on seating surfaces so as to assure non-rocking fit in any position and interchangeability of covers.

B. All manhole frames and covers shall be locking type.

C. All other lids shall be locking, unless otherwise directed by Northshore Utility District.

D. Manhole frame and cover shall be East Jordan Ergo Assembly, Part No. 001040105L01.

E. Cleanout frame and cover shall be locking type equal to Armorcast Polymer Concrete Box Assembly with Pentahead locking bolt style and “CO” imprinted on cover, part number A6001423TA.

2.4 ACCESSORIES

A. Tracing Wire: Brightly colored green No. 12 AWG insulated copper wire with plastic covering.

2.5 EARTHWORK

A. Pipe Gravel Bedding
1. Flexible Pipe: Bedding material shall consist of clean, granular, manufactured pea gravel conforming to the following gradation:

U. S. Standard Sieve Size	% Passing by Weight
1/2"	100
3/8"	85 – 95
No. 4	5 – 15
No. 8	0 – 2

B. Trench Backfill
1. Native material may be used for trench backfill if the material meets the requirements of Section 9-03.14(2) of the 2016 Standard Specifications for Road, Bridge and Municipal Construction of the Washington State Department of Transportation for Select Borrow. Native material shall be free from wood waste, organic waste, coal, charcoal, and other extraneous or objectionable materials and shall have no material larger than 2” in diameter. The material shall be non-plastic and shall not contain more than 3 percent organic material by weight.
2. Imported gravel backfill shall be a granular material conforming to Section 9-03.14(1) of the 2016 Standard Specifications for Road, Bridge and Municipal Construction of the Washington State Department of Transportation.
3. Where designated on the Contract Drawings, as required by the roadway permitting agency or as directed by the District, the trench backfill shall be controlled density fill (CDF), as manufactured by Cadman, inc., product #110021, “Pro-Flow Trench Five Hour”, or District approved equal.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavating and trenching is specified in Section 312000, “Earthwork.”

B. Conform to Northshore Utility District – Water and Sewer Specifications and Sewer Standard Detail No. 11 for trench backfill and compaction requirements.

3.2 IDENTIFICATION

A. Materials and their installation are specified in Section 312000, “Earthwork.” Arrange for installing locate wire directly over piping and at outside edges of underground structures.

1. Use locate wire according to Section 312000, “Earthwork.”

3.3 SEWER PIPE INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground sanitary sewerage piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer’s written instructions for using lubricants, cements, and other installation requirements. Maintain swab or drag in line, and pull past each joint as it is completed.

C. Use manholes for changes in direction, unless fittings are indicated. Use fittings for branch connections, unless direct tap into existing sewer is indicated.

D. Use proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. Install gravity-flow piping and connect to building’s sanitary drains, of sizes and in locations indicated. Terminate piping as indicated.

F. Unless specified otherwise, a 10-foot horizontal separation and an 18-inch vertical separation must be maintained between all sanitary sewer mains and water mains in accordance with the Department of Ecology criteria. Where it is necessary to cross an existing asbestos-cement water line, the asbestos-cement pipe shall be removed and replaced with ductile iron pipe in accordance with the Standard Detail. All other non-metallic water main crossings shall be backfilled with CDF per NUD Standard Sewer Details.

G. Connect To Existing System: Connections to existing manholes shall be made by core-drilling. Invert of manhole shall be rechannelized as necessary to accommodate flow directions and provide a minimum of 0.10' drop from the inlet to the outlet. Connections shall be watertight. If connection is made to an existing manhole with a fiberglass reinforced plastic baseliner, the disturbed channel must be re-glassed by a District approved Contractor.

H. Plug(s) For Existing System: Northshore Utility Districtshall furnish and install a plug at the time the project is connected to Northshore Utility District’s sewer system. The plug(s) must remain in position to prevent debris and water from entering the existing sewer system until such time as the sewer system within the project has been accepted by Northshore Utility District for maintenance and operation. A $2,000.00 fine shall be levied against the Contractor when a District installed sewer mainline plug is removed at any time during the work. The Contractor shall also be accountable for all expenses incurred to clean and flush sanitary sewer mainlines as a result of said plug removal.

I. Pipe Laying: The sewer pipe, unless otherwise approved by Northshore Utility District, shall be installed upgrade from point of connection on the existing sewer or from a designated starting

point to line and grade per approved plans. The sewer pipe shall be installed with the bell end forward or upgrade. When pipe laying is not in progress, the forward end of the pipe shall be kept tightly closed with an approved temporary plug. A 3” wide, green metallic sewer detector tape shall be laid 24” above the pipe bedding, for the entire length of the sewer main between manholes. Identification on the tape shall include the words “Sanitary Sewer”.

J. Pipe Jointing: All extensions, additions and revisions on the sewer system, unless otherwise indicated, shall be made with sewer pipe joined by means of a flexible gasket which shall be fabricated and installed in accordance with these specifications. All joints shall be made up in strict compliance with the manufacturer's directions and all sewer pipe manufacturing and handling shall meet or exceed the ASTM recommended specifications, current revisions. Pipe handling after the gasket has been affixed shall be carefully controlled to avoid disturbing the gasket and knocking it out of position or loading it with dirt or other foreign material. Any gaskets so disturbed shall be removed, cleaned, re-lubricated, if required, and replaced before the re-joining is attempted. Care shall be taken to properly align the pipe before joints are entirely forced home. During insertion of the tongue or spigot, the pipe shall be partially supported by hand, sling or crane to minimize unequal lateral pressure on the gasket and to maintain concentricity until the gasket is properly positioned. Sufficient pressure shall be applied in making the joint to assure that it is home, as described in the installation instructions provided by the pipe manufacturer.

3.4 SIDE SEWER STUBS

A. A side sewer stub is considered to be that portion of a sewer line that shall be constructed between a main sewer line and an easement limit. All applicable specifications given herein for sewer construction shall be held to apply to side sewer stubs.

B. A 3" wide, green metallic side sewer detector tape shall be laid 24" above the pipe bedding, for the entire length of the side sewer which is 8’ deep or less continuing up the side sewer 2”x4” marker post. Identification on the tape shall include the words "Sanitary Sewer".

C. Side sewers shall be single and installed according to the Standard Details. In no case may the specified side sewers be changed without the approval of Northshore Utility District.

D. Side sewers shall be connected to the tee provided in the sewer main where such is available utilizing approved fittings or adapters. The side sewer slope shall be a maximum of 100 percent (45 degrees) and a minimum of 2 percent. The maximum bend permissible at any one fitting shall not exceed 45 degrees. Bends exceeding 45 degrees with any combination of two fittings shall have a straight pipe of not less than two (2) feet in length installed between such adjacent fittings, unless one of such fittings be a wye branch with a cleanout provided on the straight leg. The maximum length of 6 inch sewer stub shall be 100 feet; minimum length shall be 5 feet unless otherwise approved by Northshore Utility District.

3.5 CLEANOUT INSTALLATION

A. Install cleanouts and riser extension from sewer pipe to cleanout at grade. Use cast-iron pipe fittings in sewer pipes at branches for cleanouts and cast-iron pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow of sewer pipe.

B. Set cleanout frames and covers in landscape areas with cast-in-place concrete block, 2.5 feet square by 8 inches deep. Set with tops 1 inch above surrounding grade.

C. Set cleanout frames and covers in asphalt concrete pavement or concrete walks with tops flush with finished surface.

3.6 TESTING GRAVITY SEWERSYSTEMS

A. Before sewer lines are accepted, all lines shall be inspected for line and grade, air tightness, deflection and television inspection. Any corrections required shall be made at the expense of the Contractor.

B. The first section of pipe not less than 300' in length installed by each crew shall be tested, in order to qualify the crew and/or the material. A successful installation of this first section shall be a prerequisite to further pipe installation by the crew. At the Contractor's option, crew and/or material qualification testing may be performed at any time during the construction process after at least three feet of backfill has been placed over the pipe.

C. Preparation For Testing: Prior to testing, the Contractor shall clean and flush all sewer lines. The Contractor shall conduct preliminary tests to confirm that the section to be tested is in an acceptable condition before requesting Northshore Utility District to witness the test. The manner and time of testing shall be subject to approval of Northshore Utility District.

D. Line And Grade: Variance from established line and grade shall not be greater than one thirty-second (1/32) of an inch per inch of pipe diameter and not to exceed one-half (1/2) inch, provided that such variation does not result in a level or reverse sloping invert; provided, also, that variation in the invert elevation between adjoining ends of pipe, due to non-concentricity of joining surface and pipe interior surfaces, does not exceed one sixty-fourth (1/64) of an inch per inch of pipe diameter, or one-half (1/2) inch maximum.

E. Low Pressure Air Test: Gravity sewers shall be tested with low pressure air, by the pressure drop method in accordance with Section 7-17.3(2)F, Low Pressure Air Test for Sanitary Sewers Constructed of Non Air-Permeable Materials, of the 2016 Standard Specifications for Road, Bridge and Municipal Construction of the Washington State Department of Transportation. The Contractor shall furnish all facilities and personnel for conducting the air test under the supervision of Northshore Utility District. The Contractor may desire to make an air test prior to backfilling for its own purposes. However, the acceptance air test shall be made after backfilling has been completed and compacted. All wyes, tees or the end of the side sewer stubs shall be plugged with flexible joint caps, or acceptable alternative, securely fastened to withstand the internal test pressures. Such plugs or caps shall be readily removable and their removal shall provide a socket suitable for making a flexible, jointed lateral connection or extension. No double plugs shall be allowed. Immediately following the pipe cleaning, the pipe installation shall be tested with low pressure air. A maximum reach to be tested shall be the reach between two consecutive manholes. Air shall be slowly supplied to the plugged pipe installation until the internal air pressure reaches 4.0 pounds per square inch greater than the average back pressure of any groundwater above the center of the pipe being tested. At least two minutes shall be allowed for temperature stabilization before proceeding further. The requirements of this specification shall be considered satisfied if the time required in seconds for the pressure to decrease from 3.5 to 2.5 lbs. per square inch greater than the average back pressure of any groundwater that may submerge the pipe is not less than the listed values shown in the following table:

Allowable Time for Pressure Drop Method

Diameter (inches)	Minimum Test Times for Length of Main (seconds)							
	50’	100’	150	200’	250’	300’	350’	400’
8	144	286	428	570	712	854	908	908
10	222	444	666	888	1110	1134	1134	1134
12	320	640	960	1280	1360	1360	1360	1462
15	500	1000	1500	1700	1700	1714	1998	2284
18	720	1440	2040	2040	2056	2468	2878	3290
24	1280	2558	2720	2924	3654	4386	5116	5846

According to the following:

*T = 4*K, for C < 1*
T = 4(K/C), for 1 £ C < 1.75*
T = 4(K/1.75), for C ³ 1.75*

*Where: C = 0.0003918*d*L*

*K = 0.0111*d2*L*
d = Pipe diameter (inches)
L = Pipe length (feet)
T = Minimum test time (seconds)

Note: All test times in the above table are rounded up to the nearest even number.

The use of air pressure for testing sewer lines creates hazards that must be recognized. The Contractor shall be certain that all plugs are securely blocked to prevent blowouts. The air testing apparatus shall be equipped with a pressure release device such as a rupture disc or a pressure relief valve designed to relieve pressure in the pipe under test at greater than 6 lbs. per square inch. Precautions shall be taken to prevent any damage caused by testing. Any damage resulting shall be repaired by the Contractor at their own expense. All visible leaks showing flowing water in pipelines or manholes shall be stopped even if the test results fall within the allowable leakage.

F. Deflection Testing: If required by Northshore Utility District, all PVC sewer pipes shall be tested for deflection not less than 30 days after the trench has been backfilled and compaction has been completed. The testing shall be conducted by pulling a properly sized mandrel through the pipe in accordance with Section 7-17.3(2)G of the 2016 Standard Specifications for Road, Bridge and Municipal Construction of the Washington State Department of Transportation.

G. Television Inspection: All sanitary sewers shall be inspected by the use of a Closed Circuit Television (CCTV) camera. The CCTV footage and corresponding inspection file database shall be exported and provided to Northshore Utility District on a USB flash storage device before final acceptance of the project. No VHS tapes or DVD-R discs will be accepted. All inspections shall be conducted in accordance with NUD standards. At the beginning of each sewer main inspection, the following information shall be electronically generated and displayed on the CCTV footage:

1. Date of inspection
2. Contractor Company Name
3. Operator Name

4. Upstream Manhole number to downstream manhole number
5. Direction of inspection (upstream or downstream)
6. Pipe material and size

During inspections, the following information shall be electronically generated, automatically updated, and displayed on the CCTV footage:

1. Inspection location in the sewer line in feet from adjusted zero
2. Manhole number to manhole number (with direction of travel US/DS)
3. Date of inspection
4. Elapsed time of inspection

Each individual sewer main inspection, from manhole-to-manhole, shall be recorded on one digital file. If a pipe reach cannot be recorded to a single digital file due to extreme pipe length or obstructions in the pipe, multiple digital files for a single pipe are acceptable. On the other hand, multiple sewer main inspections recorded on a single digital file shall not be accepted. All CCTV inspections shall be furnished by the Contractor. This CCTV inspection shall be performed prior to final restoration of the street or easement. The Contractor shall inform Northshore Utility District ahead of time when and which lines are ready to be inspected. The Contractor shall bear all costs incurred in correcting any deficiencies found during the CCTV inspection including the cost of any additional CCTV inspection that may be required by Northshore Utility District to verify the correction of said deficiency. The project shall not be accepted by Northshore Utility District until the CCTV inspection has been performed.

3.7 MANHOLE VACUUM TESTING

A. All manholes shall be vacuum tested in accordance with ASTM C1244-05 to verify water tightness. All manhole penetrations shall be blocked or sealed and braced prior to the testing in order to prevent pipes, boots, gaskets or any other materials from being drawn into the manhole. A vacuum of ten (10) inches of Hg shall be drawn on the manhole and the vacuum pump shut off. The time for the vacuum on the manhole to drop from ten (10) inches of Hg to nine (9) shall be measured and the manhole shall have passed the vacuum test if the time measured is greater than shown in the following table:

Minimum Test Times for MH Vacuum Testing

MH Diameter (inches)	Depth (feet)									
	8 or less	10	12	14	16	18	20	22	24	26
	Time (seconds)									
48	20	25	30	35	40	45	50	55	59	64
54	23	29	35	41	46	52	53	64	64	75

B. If the time required for the pressure to drop from 10 inches of Hg to 9 inches of Hg is less than the value indicated in the table, the manhole shall be rejected by Northshore Utility District and shall be repaired or replaced and re-tested by the Contractor.

3.8 FIELD QUALITY CONTROL

A. Test piping systems for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.
2. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours advance notice.
3. Submit separate reports for each test to Architect and Engineer.
4. Leaks and loss in test pressure constitute defects that must be repaired.
5. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

B. Copies of cleaning and testing reports shall be provided to Architect and Civil Engineer.

3.9 PROTECTION

A. Protect finished installation from any disturbance.

B. Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress. Damaged materials shall be replaced at the Contractor’s expense.

END OF SECTION 333100

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. Work of this Section includes, but is not limited to, the following:

1. Storm drainage piping, fittings, and accessories.
2. Catch basins and manholes.
3. Connection of building downspouts to roof downspout tight-line.
4. Underground storm detention vault and treatment systems.
5. Temporary connections to existing and/or new system.
6. Cleaning storm system at completion of project.

B. Related Sections include the following:

1. Section 334613, “Foundation Drainage”.
2. Section 312000, “Earth Moving” for trenching, bedding, and backfilling.

1.3 DEFINITIONS

A. CPEP: Corrugated polyethylene plastic pipe.

B. DIP: Ductile Iron Pipe.

C. PVC: Polyvinyl chloride plastic pipe.

1.4 REFERENCE STANDARDS

A. WSDOT Standard Specifications for Road, Bridge, and Municipal Construction, latestedition.

B. WSDOT: Standard Plans for Municipal Construction, latest edition.

C. City of Kenmore Engineering Design and Development Standards, latest edition.

D. King County Stormwater Design Manual, latest edition.

1.5 PERFORMANCE REQUIREMENTS

A. Gravity-Flow, Nonpressure-Piping Pressure Ratings: At least equal to system test pressure.

B. All work within public right-of-way shall conform to City of Kenmore requirements.

C. No storm utility trench shall be backfilled until inspected by the City of Kenmore Inspectors.

1.6 SUBMITTALS

A. Submit under provisions of Section 013300, “Submittal Procedures” and as further provided.

B. Submittals that have been submitted and approved shall be available onsite for reference by the Owner and Engineer.

C. Certification:

1. Provide a letter, signed by the supplier and reviewed and also signed by an officer of the Contractor's company, certifying that the following products to be incorporated into the work meet the requirements specified.
2. All product submittals shall be submitted to the Engineer for review and approval. Storm system construction shall not commence until all submittals have been approved by the Engineer.
3. Products:
   a. Filterra Systems as shown on the plans
   b. Storm detention vault and associated appurtenances
   c. Roof Downspout Connection Accessories as shown on the plans
   d. Catch Basins, Frames and Grates
   e. Manhole, Frames and Grates
   f. Locating Wire
   g. Storm Drainage Pipe
   h. Cleanouts
   i. Pipe Couplings
   j. Ethafoam
   k. Geotextile Fabric as shown on the plans
   l. Pipe Bedding Material - see Earth Moving specifications
   m. Pipe Backfill Material - see Earth Moving specifications
4. Record drawings according to Section 017700, "Closeout Procedures" and Section 017839, "Project Record Documents."
   a. Record information shall be provided by a Professional Land Surveyor that is licensed in the State of Washington.
   b. Minimum record information shall include utility field changes during construction and indicating as-constructed pipe slopes, invert and rim elevations.
5. Television Inspection Report: Prepared by a firm licensed to perform such analysis, submitted to the Architect a minimum of 30-days before final surfacing construction is scheduled. The following shall be submitted:
   a. Video recording on DVD of constructed conditions of pipes, joints, and structures. Inspection shall be accomplished using a 360 degree radial view color television camera.
   b. Written report documenting stations of sags, improper joints, connections or other areas of concern. Contractor shall provide written proposal for repairs to mitigate all areas of concern or non-conforming conditions.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic structures, pipe, and fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

C. Handle precast concrete manholes and other structures according to manufacturer's written rigging instructions.

1.8 PROJECT CONDITIONS

A. Site Information: Perform site survey, research public utility records, and verify existing utility locations. Field verify all connection points of existing facilities and immediately contact Architect if proposed improvement cannot be provided.

B. Locate existing structures and piping to be closed and/or abandoned.

C. Existing Utilities: Utility interruptions shall not be allowed unless permitted under the following conditions and then only after arranging to provide temporary services according to requirements indicated:

1. Notify Architect not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect's written permission.
3. Project requires connections to existing and new storm systems.
   a. Contractor is responsible for all demolition, trenching, bedding, pipe installation, backfill, compaction, and final surfacing.
   b. Work includes any temporary pumping of existing drainage flows to allow construction of new storm systems.

D. Provide temporary connections to existing or new storm systems as necessary to maintain and control storm drainage flow on the project site and meet other construction phasing requirements.

E. Geotechnical reports of subsurface condition investigations made during the Project design are available for informational purposes only; data in these reports are not intended as representations or warranties of accuracy or continuity of conditions between field investigation points (i.e. soil borings, test pits, etc.). Owner assumes no responsibility for interpretations or conclusions drawn from this information.

PART 2 - PRODUCTS

2.1 PIPES AND FITTINGS

A. PVC Sewer Pipe and Fittings: PVC pipe for diameters 4 inch through 24 inch shall conform to ASTM 3034, SDR 35. Conforming to WSDOT Specification 9-05.12(1). Pipe interior shall be smooth and meet a roughness coefficient of 0.012.

B. Ductile-Iron Pipe: Ductile iron shall be Class 50; cement mortar lined conforming to AWWA C151. Ductile iron pipe shall be push-on joint. Pipe shall be furnished with a single rubber ring gasket lubricated to effect the seal. The Contractor shall furnish certification from the manufacturer of the pipe and gasket being supplied that the inspection and all of the specified tests have been made and the results thereof comply with the requirements of this standard.

C. Downspout Connection to Storm System: Tie-in pipe shall be solid PVC pipe. All pipes shall be 6 inches in diameter, except as otherwise indicated on the drawings.

D. Cleanouts: Provide in quantities and locations shown on the drawings, but not less than at end of runs, changes in direction, and intervals of 100 feet. Provide cleanouts at each downspout.

2.2 CATCH BASINS AND MANHOLES

A. Precast Concrete Catch Basin, Frame, and Grates: Conform to City of Kenmore Public Works and WSDOT standards. Catch basin grates installed in concrete walkways shall meet ADA standards.

B. Precast Concrete Manhole, Frame, and Grates: Conform to City of Kenmore Public Works and WSDOT standards. Manhole grates installed in concrete walkways shall meet ADA standards.

2.3 CLEANOUTS

A. Conform to detail on plans.

B. Lids shall be locking.

2.4 CONCRETE STORM DETENTION VAULT

A. Provide cast-in-place concrete storm detention vault as shown on the plans. Contractor shall provide submittals for all portions of the storm detention vault.

2.5 FILTERRA TREATMENT UNITS

A. Provide units with supporting connections conforming to details shown on the plans.

2.6 PIPE ACCESSORIES

A. Pipe Joints: Gasket for positive seal for all non-perforated pipe.

B. Fittings: Prefabricated same material as pipe molded or formed to suit pipe size and end design, or as per manufacturer, in required tee, bends, elbows, cleanouts, reducers, traps, and other configurations required.

C. Pipe Couplings: Flexible coupling adapters shall meet the specifications set forth in the AWWA Standard C219 coupling specification and be rated for working pressures up to 250 psi. Flexible coupling adapters shall be Romac XR501, Hymax 2000, or approved equal.

D. Locate Wire: No. 12 AWG insulated copper wire, brightly colored green plastic covering.

E. Detectable Warning Tape: See Section 312000, “Earth Moving.”

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Section 312000, “Earth Moving.”

3.2 IDENTIFICATION

A. Materials and their installation are specified in Section 312000, “Earth Moving.” Arrange for installing green warning tapes or locating wire directly over piping and at outside edges of underground structures.

1. Use warning tape or locating wire over ferrous piping.
2. Use locating wire over nonferrous piping and over edges of underground structures.
3. Use locating wire on all roof drain systems.

3.3 STORM DRAINAGE INSTALLATION

A. General Locations and Arrangements: Drawings and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated on the plans.

B. Install piping beginning at low point, true to grades, and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab or drag in line, and pull past each joint as it is completed.

C. Use manholes or catch basins for changes in pipe direction, slope, size, or material type.

D. Reducing size of piping in direction of flow is prohibited.

E. Coordinate between utility subcontractor and vault subcontractor for construction of Filterra systems and concrete storm detention vault.

F. Stencil all new catch basins with “Dump No Waste – Drains to Stream”.

3.4 PIPE JOINT CONSTRUCTION AND INSTALLATION

A. General: Join and install pipe and fittings according to installations indicated.

B. Ductile-Iron Pipe with Ductile-Iron Fittings: According to AWWA C600.

C. Install with top surfaces of components, except piping, flush with finished surface.

D. Provide all fittings as necessary to connect downspouts to roof drains as shown on the plans. See architectural plans for downspout locations.

1. No above-grade offsets shall be allowed. Installation shall conform to detail.
2. Minimum pipe slope to storm system shall be 1.0 percent unless otherwise indicated.

E. Provide all fittings as necessary to connect foundation drainage to storm system. See architectural and structural plans for building footing configurations, locations, and depths. See civil plans for layout of foundation drainage system.

1. Minimum pipe slope to storm system shall be 1.0 percent.

F. Footing Drains: Install footing drains around perimeter of buildings. Install and conform to detail on plan. Connect to storm drainage system. Provide bedding and backfill in accordance with Section 312000, “Earth Moving”.

G. PVC Sewer Pipe and Fittings:

1. Install according to ASTM D2321.

H. System Pipe Joints: Make joints using system manufacturer's couplings, unless otherwise indicated by the City of Kenmore.

I. Join piping made of different materials or dimensions with couplings made for this application. Use couplings that are compatible with and that fit both systems' materials and dimensions.

3.5 MANHOLE, CATCH BASIN, AND AREA DRAIN INSTALLATION

A. Construct catch basins to sizes and shapes indicated.

B. Set frames and grates to elevations indicated.

C. Grout all seams and opening in all manholes, catch basins, and area drains.

D. Adjust lids after final paving.

3.6 CLEAN OUT INSTALLATION

A. Provide cleanouts and riser extension as shown on the plans. Conform to detail on plan.

B. Cleanout lid and concrete collar shall be flush with finish grade.

C. Cleanouts shall be provided on the roof downspout tight-line and foundation drainage systems as shown on the plans.

3.7 PROTECTION

A. Storm drain facilities shall be protected from contamination by debris and sediment-laden water.

3.8 CLOSE ABANDONED STORM DRAINAGE SYSTEMS

A. Abandoned Piping: Cap open ends of abandoned underground piping indicated to remain in place. Include caps strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been capped.

1. Cap open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for the size and type of material being closed. Do not use wood plugs.
2. Conform to City of Kenmore and WSDOT requirements.

B. Abandoned Structures: Excavate around structure as required and use one procedure below:

1. Remove structure and cap open ends of remaining piping. Backfill to grade according to Section 312000, “Earth Moving.”
2. Remove top of structure down to at least 36 inches below final grade. Fill to within 12 inches of top with crushed surfacing top course. Fill to finished grade with Imported Structural Fill.Backfill to grade according to Section 312000, “Earth Moving.”

3.9 FIELD QUALITY CONTROL

A. Clear interior of piping and structures of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed.

1. In large, accessible piping, brushes and brooms may be used for cleaning.
2. Place plug in end of incomplete piping at end of day and when work stops.
3. Flush piping between manholes and other structures to remove collected debris, if required by authorities having jurisdiction.

B. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24inches of backfill is in place, and again at completion of Project.

1. Defects requiring correction include the following:
   a. Alignment: Less than full diameter of inside of pipe is visible between structures.
   b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
   c. Crushed, broken, cracked, or otherwise damaged piping.
   d. Infiltration: Water leakage into piping.
   e. Exfiltration: Water leakage from or around piping.
2. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
3. Reinspect and repeat procedure until results are satisfactory.

C. Cleaning and Testing: Conform to written City of Kenmore requirements. If written City of Kenmore requirements are not available, clean and test in accordance with WSDOT Sections 7-04 and 7-17.

1. At completion of project, the entire storm drainage system shall be cleaned utilizing a vactor type system. Work includes cleaning out manholes, catch basins, area drains and pipes.

END OF SECTION 334100

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. Work of this section includes but is not limited to the following:

1. Foundation drain for new buildings.
2. French drains to collect stormwater runoff.
3. Connection of foundation and french drains to storm system.

B. Related sections include the following:

1. Section 312000, “Earth Moving” for soil materials, excavating, and backfilling.
2. Section 334100, “Storm Drainage.”

1.3 DEFINITIONS

A. PVC: Polyvinyl chloride plastic pipe.

1.4 REFERENCE STANDARDS

A. WSDOT Specification: Standard Specifications for Road, Bridge, and Municipal Construction, prepared by the Washington State Department of Transportation, latest edition. All references to measurement and payment shall be deleted from consideration; and the terms agreed to in the Contract substituted therefore.

B. WSDOT: Standard Plans for Road, Bridge and Municipal Construction, latestEdition.

C. Conform to OSHA (Occupational Safety and Health Act) requirements.

D. Conform to WISHA (Washington State Industrial Safety and Health Act) for trench safety.

1.5 PROJECT CONDITIONS

A. The Contractor shall utilize a utility locate service, notify affected utility companies before starting work, and comply with all applicable requirements.

B. The Contractor shall conform to applicable regulatory procedures when discovering hazardous or contaminated materials.

C. Geotechnical reports of subsurface condition investigations made during the Project design are available for informational purposes only; data in these reports are not intended as representations or warranties of accuracy or continuity of conditions between field investigation points (i.e. soil borings, test pits, etc.). Owner assumes no responsibility for interpretations or conclusions drawn from this information.

D. The locations of existing underground utilities are approximate and have not been independently verified by the Owner or its representatives. The Contractor shall determine the exact locations of all existing utilities before commencing work and agrees to be fully responsible for any and all damages that occur due to the Contractor's failure to appropriately locate utilities and preserve all underground utilities that are designated to remain.

1.6 SUBMITTALS

A. Submit under provisions of Section 013300, "Submittal Procedures" and as further provided.

B. Submittals that have been submitted and approved shall be available onsite for reference by the Owner and Engineer.

C. Certification:

1. Provide a letter, signed by the supplier and reviewed and also signed by an officer of the Contractor's company, certifying that the following products to be incorporated into the work meet the requirements specified.
2. All product submittals shall be submitted to the Engineer for review and approval. Foundation drainage construction shall not commence until all submittals have been approved by the Engineer.
3. Products
   a. Pipe (perforated and non-perforated).
   b. Filter fabric.
   c. Gravel backfill for drains.

D. Record drawings according to Section 017700, "Closeout Procedures" and Section 017839, "Project Record Documents."

1. Record information shall be provided by a Professional Land Surveyor that is licensed in the State of Washington.
2. Minimum record information shall include utility field changes during construction and indicating as-constructed pipe slopes, invert and rim elevations.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic structures, pipe, and fittings in direct sunlight.

B. Protect pipe, pipe fittings and seals from dirt and damage.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Foundation and French Drainage Piping/Accessories

1. Provide perforated and non-perforated PVC pipe conforming to ASTM D3034 SDR-35. See plans for pipe diameter. Perforations shall be two rows of ½-inch holes, 5 inches on center, 120 degrees apart. All joints shall be solvent welded.
2. Corrugated flexible plastic pipe is not permitted.

3. Provide non-perforated PVC piping for connecting footing and french drains to the storm system.

B. Filter Fabric

1. Filter fabric to surround washed gravel and perforated piping as shown on the plans for foundation drains shall be Mirafi 140N or approved equivalent.

C. Gravel Backfill for Perforated Pipe

1. The gravel envelope around the perforated pipe and against building foundation walls shall consist of ¾-inch clean washed pea gravel conforming to WSDOT Standard Specifications 9-03.12(4), "Gravel Backfill for Drains."

D. Trench Backfill Material

1. Provide trench backfill materials as specified under Section 312000, “Earth Moving.”

PART 3 - EXECUTION

3.1 TRENCH EXCAVATIONS

A. Excavating and Trenching

1. Use previously excavated trenches for building foundations to install footing drains at the perimeter of the building and at retaining walls. Excavate additional trenches for foundation drainage as indicated and otherwise required for connection to the storm system.
2. The Contractor shall perform excavation as necessary to the lines and grades indicated on the Contract Documents.
3. All materials suitable for use as backfill shall be piled in an orderly manner with sufficient distance from the bank of the trench to avoid overloading and to prevent sliding into the trench.
4. The Contractor shall do such work as is necessary to prevent surface water from entering the excavation trench.
5. Refer to Section 312000, “Earth Moving” for further requirements.

3.2 PIPE INSTALLATION

A. General

1. All pipes shall be installed in strict accordance with the manufacturer's recommendations, Contract plans, and/or specifications using the best trade practices of the industry.
2. The Contractor shall perform all work to cut pipes, fittings, or special castings necessary to properly and accurately assemble, erect, and complete the work. All pipes shall be cut to fit accurately with smooth edges and faces.
3. Special tools required for laying, jointing, cutting, etc., shall be supplied and properly used by the Contractor.
4. All pipes shall be thoroughly cleaned before laying and shall be kept clean until accepted in the completed work.
5. At all times during pipe installations, the trench shall be kept free of water, with sumps and pumps as necessary, to prevent water and debris from entering new pipe being laid.

6. All pipes shall be constructed from the materials specified and to the lines, grades and dimensions indicated.
7. Pipes shall be laid and fitted together so that, when complete, it shall have a smooth and uniform grade.
8. Each length of pipe shall be thoroughly swabbed to remove all foreign material before the next length is laid; each pipe shall be inspected for defects before being lowered into the trench.
9. Perforations of the perforated pipe shall be kept unclogged prior to, during, and after installation.

B. Preparatory Work of Other Sections

1. Do not install foundation drainage or associated pipes until damp-proofing has been properly applied and cured.

C. Foundation Drainage Pipe Installation

1. Place foundation drainage pipe at all exterior perimeter wall footings and on the uphill side of all retaining walls as indicated on the plans.
2. Foundation drains shall be constructed with sufficient slope to allow gravity discharge away from the building or wall to the storm system as shown on the plans.
3. Trim the bottom of foundation excavations lower by 2- to 4-inches to the pipe invert, for the full cross-sectional width of the pipe, with even downward slope to the stormsystem.
4. Place 2- to 4-inches minimum depth of gravel in the bottom of the trench excavation.
5. Lay filter fabric over gravel base full trench width, with ends of each roll lapped 3 feet minimum from the upstream to downstream roll. The width of the fabric shall be enough to conform to the trench perimeter with at least 12 inches of top overlap upon installation of gravel backfill. Install carefully so as not to tear or punch holes in fabric.
6. Carefully place pipe with even downward slope. Lay drain pipe using couplings, bends, and fittings as necessary. Install cleanouts as shown on the plans and as necessary to provideappropriate maintenance access to the system.
7. Provide gravel backfill around and over foundation drain pipe to provide 12-inches of minimum cover over the pipe.
8. Backfill and compact remaining portion of foundation drainage trench with backfill material as specified under Section 312000, “Earth Moving.”
9. Exterior grades adjacent to buildings and walls shall be sloped downward away from the proposed structure.

3.3 CONNECTION TO STORM DRAINAGE SYSTEM

A. Connect low end of foundation and french drains to the storm system at catch basins and manholes as shown on the plans.

B. Do not connect foundation drains to the building’s roof drainage system. Roof runoff shall not discharge into the footing drain system and shall be handled by a separate drainage tight-line.

C. Special precautions shall be taken when performing work in close proximity to existing or new foundation drainage systems. Where the work has damaged existing or new foundation drainage systems, the damaged foundation drain shall be repaired or replaced to the satisfaction of the Owner or Engineer.

END OF SECTION 334613